# Nutritional Benefits of Clover Honey Supplementation in Malnourished Children: Effects on Growth and Lipid Profiles

**Original Article**

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## ABSTRACT

**Background:** In the Egyptian context, malnutrition is a substantial health problem that affect both growth, and development of growing children. Chronic malnutrition has deleterious effect on bodily metabolic functions, giving rise to a multitude of metabolic dysregulations. Among these, dyslipidemia has been identified as a prominent concern.

**Aim:** The study examined the potential benefits of clover honey supplementation on growth and lipid metabolism in malnourished infants and children.

**Methods:** This randomized prospective interventional study was conducted on 40 malnourished infants and children divided into two equal groups: Group A received honey in a dose of 1.75ml/kg/day plus the WHO recommended nutritional interventional for 12 weeks and Group B received only WHO recommended nutritional interventional. Anthropometric measurements and fasting lipid profile levels were measured at baseline and after 3 months

**Results:** A statistically significant discrepancy in the rate of change was observed between the two groups with respect to weight, height, and body mass index. The *p-value* for all three variables was 0.000, indicating a high level of statistical significance. Similar findings were also observed regarding the rate of change of the lipid profile. Serum triglycerides, cholesterol, and LDL all decreased, while HDL increased. The *p-value* for all four variables was 0.000.

**Conclusions:** Honey consumption significantly improved nutritional status and lowered lipid profile, making it a promising, affordable solution for tackling malnutrition in low-income countries.

**Key Words:** Dyslipidemia, honey, malnutrition, pediatrics.

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## INTRODUCTION

According to the World Health Organization (WHO), malnutrition constitutes a significant health problem, with an estimated 45 million children affected by wasting and 149 million affected by stunting on an annual basis [1]. In the Egyptian context, the prevalence of malnutrition is a significant issue. It represents a major health threat which affects both growth, and development of growing children[2]. Chronic malnutrition negatively affects the metabolic functions of all body systems, resulting in increased cortisol secretion and a decreased resting metabolic rate, the purpose of which is to conserve energy. These changes together with other endocrine changes, and decreased lipid peroxidation leads to reduced growth in children, alteration in their lipid profiles, and increase in the visceral adiposity [3]. Eating disorders with chronic undernutrition specially anorexia nervosa found to be associated with dyslipidemia [4].

Honey is a natural substance produced by honeybees[5]. It is a nutrient-rich food consisting of approximately 75% carbohydrates (mainly fructose and glucose), 3% protein, and 19% water. Beyond being highly nutritious food, honey boasts medicinal and health-promoting properties including antibacterial effects, anti-inflammatory properties, antihypertensive and cardio-protective, antioxidant properties, antifungal, antiviral effects, and potential anti-tumor benefits. Honey has been recognized for its diverse benefits for centuries, thus establishing its value as a natural remedy [6]. The unique combination of different bioactive compounds like enzymes, organic acids, vitamins, minerals, and phenolic compounds in the honey has been demonstrated to yield these effects [7]. Honey has been utilized as a

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medicinal agent for a greater duration than as a nutrient, and it is held in high esteem in the Middle Eastern region [8]. The hypolipidemic effect of honey (modulating total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triacylglycerol) is attributed mainly to its phenolic compounds this carries a potential role for using honey to improve dyslipidaemia and decrease cardiometabolic risks [8,9].

Despite all the previously mentioned potential biological functions of honey, the precise effects of honey consumption on the lipid profile remain a subject of considerable debate[9]. A paucity of clinical studies has been observed that have focused on the effect of honey on dyslipidemia, particularly in pediatric patients with malnutrition. The objective of this study was to evaluate the effect of clover honey supplementation on the anthropometric measurements and lipid profile of malnourished infants and children.

## MATERIAL AND METHODS

### Study design and population

This was a randomized prospective interventional study, conducted in the Pediatric Nutrition Clinic of Ain Shams University during the period from November 2019 to November 2020.

## ETHICAL APPROVAL

The study was conducted after the approval of the local institutional review board (MS 518/2019) on [22/12/2019] with the acquisition of informed consent from the child and/or the caregiver.

The study population consisted of 40 moderate to severe undernourished children defined according to the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition definition[10] with age ranging between 1-5 years. Children with severe systemic illness, malabsorption, positive family history of dyslipidemia or inborn error of metabolism were excluded. Patients were randomized to receive either honey (group 1) or nothing (group 2), beside the conventional nutritional rehabilitation therapy primarily based on the World Health Organization recommendations.

### Study tools:

### Clinical assessment

- Detailed history taking and clinical examination with special emphasis on dietetic history and nutrition focused clinical examination.

- Anthropometric assessment: including body weight, length/height, weight for length/ BMI, midarm circumference. All the measures were taken by two trained personnel then plotted on WHO, or CDC growth charts and Z score tables according to age [11, 12]. Body weight was measured to the nearest 0.1kg by using a standard digital scale, body Length was measured using infantometer, while height was measured using stadiometer both readings were approximated to the nearest 1cm, Body Mass Index which was calculated using the following equation BMI = Weight (kg)/length $(m)^2$.

### Biochemical assessment:

After 8 to 12-hour fasting, blood samples were withdrawn by nurses then collected in plain sterile tubes. After centrifugation blood serum was separated. Serum samples were sent for measurement of fasting lipid profile including total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides (TGs) (Au680, Beckman by spectrophotometry technique).

### Intervention:

- The study group was randomly allocated into two subgroups each consists of 20 patients:

1. Group 1: received honey in a dose of 1.75 ml/kg/day, the doses were grouped and given twice weekly for 12 weeks to ensure compliance [13] in addition to conventional nutritional rehabilitation program primarily based on the World Health Organization recommendation [14].

2. Group 2: received only conventional nutritional rehabilitation program primarily based on the World Health Organization recommendation [14] for 12 weeks.

After 12 weeks the two groups of patients studied were reevaluated using the same study procedures mentioned before.

### Statistical analysis:

Data were analyzed using the Statistical Package for Social Science (IBM SPSS) version 23. Qualitative data were presented as number and percentages. Groups with qualitative data were compared using Chi-square test. The quantitative data were presented as mean+/- standard deviations when normally distributed and ranges were included. Comparison between two groups with quantitative data were done by using independent t-test (normally distributed). The comparison between two paired groups with quantitative data (normally distributed) were done by using Paired t-test. All tests were two sided with 95% confidence interval. The *p-value* was considered significant when $< 0.05$.

## RESULTS

### Descriptive statistics

The study population consisted of 40 children diagnosed with malnutrition according to the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition definition [10], the mean age was 31.95 ± 11.30 months (11 males and 9 females) in group (1), and 31.40 ± 14.29 months (6 males and 14 females) in group (2) with no statistically significant difference between groups. Regarding anthropometric data and lipid profile there were no statistically significant difference between the two groups at the start of the study as shown in (Table 1).

**Table 1:** Baseline anthropometric measurements, and lipid profile of both groups.

| | | Group (1) | Group (2) | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = 20 | No. = 20 | | |
| Weight | Mean ± SD | 9.49 ± 2.03 | 9.53 ± 1.89 | -0.064 | 0.949 |
| (Kg) | Range | 5 – 13 | 6.9 – 12.6 | | |
| Height | Mean ± SD | 81.45 ± 8.31 | 82.63 ± 10.86 | -0.384 | 0.703 |
| (cm) | Range | 67 – 97 | 68 – 101 | | |
| Weight/ Length | Mean ± SD | 14.24 ± 2.15 | 14.00 ± 1.64 | 0.396 | 0.694 |
| BMI (Kg/m$^2$) | Range | 11.13 – 20.4 | 11.27 – 17.65 | | |
| HDL | Mean ± SD | 35.70 ± 3.34 | 39.55 ± 3.35 | -3.640 | **0.001** |
| (mg/dl) | Range | 31 – 44 | 33 – 45 | | |
| LDL | Mean ± SD | 109.30 ± 13.19 | 110.25 ± 14.73 | -0.215 | 0.831 |
| (mg/dl) | Range | 84 – 133 | 82 – 144 | | |
| Cholesterol | Mean ± SD | 178.00 ± 20.91 | 176.70 ± 18.69 | 0.207 | 0.837 |
| (mg/dl) | Range | 135 – 201 | 130 – 205 | | |
| Triglycerides | Mean ± SD | 86.10 ± 13.96 | 86.75 ± 11.73 | -0.159 | 0.874 |
| (mg/dl) | Range | 60 – 108 | 65 – 103 | | |

BMI, Body Mass Index, HDL, high density lipoprotein, LDL, low density lipoprotein
•: Independent t-test

### Comparative data:

- With respect to anthropometric measurements, the present study demonstrated a substantial increase in weight and length/height in both groups 1 and 2 (with *P-values* of 0.000 and 0.000, respectively in group 1 and 0.011 and 0.000, respectively in group 2) following a three-month period of observation. A statistically significant increase in BMI was observed exclusively in Group 1 following a three-month period of observation as demonstrated in (Tables 2, 3).

**Table 2:** Comparison between anthropometric measurements of group 1 at base line and after 3 months.

| Group 1 | | Base line | 3-month interval | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = 20 | No. = 20 | | |
| Weight (Kg) | Mean ± SD | 9.49 ± 2.03 | 10.91 ± 2.11 | -14.329 | **0.000** |
| | Range | 5 – 13 | 6.214.7 | | |
| Height (cm) | Mean ± SD | 81.45 ± 8.31 | 84.80 ± 8.23 | - 17.120 | **0.000** |
| | Range | 67 – 97 | 70 – 100 | | |
| BMI (kg/m$^2$) | Mean ± SD | 14.24 ± 2.15 | 15.07 ± 2.05 | -5.444 | **0.000** |
| | Range | 11.13 – 20.4 | 12.37 – 21.33 | | |

Note: $p < 0.05$: Significant (Bold).
Abbreviations: BMI, Body Mass Index.
•: Independent t-test

**Table 3:** Comparison between anthropometric measurements of group 2 at base line and after 3 months.

| Group 2 | | Baseline | 3-month interval | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = 20 | No. = 20 | | |
| Weight (Kg) | Mean ± SD | 9.53 ± 1.89 | 9.83 ± 2.01 | -2.814 | **0.011** |
| | Range | 6.9 – 12.6 | 7.2 – 12.9 | | |
| Height (cm) | Mean ± SD | 82.63 ± 10.86 | 84.00 ± 11.16 | -6.242 | **0.000** |
| | Range | 68 – 101 | 70 – 103 | | |
| Body mass index | Mean ± SD | 14.00 ± 1.64 | 13.96 ± 1.65 | 0.323 | 0.750 |
| ($Kg/m^2$) | Range | 11.27 – 17.65 | 11.31 – 17.65 | | |

Note: $p < 0.05$: Significant (Bold); Abbreviations: BMI, Body Mass Index; •: Independent t-test

- The present study demonstrated a substantial decrease in serum triglycerides, LDL, and total cholesterol (with *P-values* of 0.000, 0.000, and 0.000, respectively) and a considerable increase in HDL in Group 1 (with *P-values* of 0.000) following a 3-month interval, as illustrated in (Table 4). no statistically significant difference in the lipid profile of group 2 at baseline and at the 3-month interval.

**Table 4:** Comparison between lipid profile of group 1 at base line and after 3 months

| Group 1 | | Base line | 3-month interval | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = 20 | No. = 20 | | |
| S.HDL | Mean ± SD | 35.70 ± 3.34 | 42.65 ± 2.80 | -15.862 | **0.000** |
| (mg/dl) | Range | 31 – 44 | 37 – 47 | | |
| S.LDL | Mean ± SD | 109.30 ± 13.19 | 95.95 ± 13.25 | 28.643 | **0.000** |
| (mg/dl) | Range | 84 – 133 | 70 – 119 | | |
| S.Cholesterol | Mean ± SD | 178.00 ± 20.91 | 162.45 ± 19.73 | 11.499 | **0.000** |
| (mg/dl) | Range | 135 – 201 | 117 – 182 | | |
| S.Triglycerides | Mean ± SD | 86.10 ± 13.96 | 76.90 ± 13.19 | 24.138 | **0.000** |
| (mg/dl) | Range | 60 – 108 | 52 – 98 | | |

Note: $p < 0.05$: Significant (Bold); BMI, Body Mass Index, HDL, high density lipoprotein, LDL, low density lipoprotein; •: Independent t-test

**Comparing the rate of change between the two groups**

- Regarding the anthropometric measurements, a statistically significant discrepancy in the rate of change was observed between the two groups with respect to reported increase in weight, height, and body mass index. The *p-value* for all three variables was 0.000, indicating a high level of statistical significance as shown in (Table 5).

**Table 5:** Comparison between rate of change in the anthropometric measurements of both groups after 3 months.

| % change | | Group 1 | Group 2 | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = 20 | No. = 20 | | |
| Weight | Mean ± SD | 15.61 ± 5.34 | 3.74 ± 4.28 | -4.883 | **0.000** |
| | Range | 5 – 24 | 0 – 15 | | |
| Height | Mean ± SD | 4.17 ± 1.23 | 1.65 ± 1.16 | -4.655 | **0.000** |
| | Range | 2.25 – 7.14 | 0 – 4.55 | | |
| Weight/ Length | Mean ± SD | 6.51 ± 4.53 | 1.22 ± 2.30 | -3.606 | **0.000** |
| BMI | Range | 0 – 13.66 | 0 – 7.16 | | |

Note: $p < 0.05$: Significant (Bold), BMI, Body Mass Index, •: Independent t-test

- A statistically significant difference in the rate of change between the two groups was observed for all parameters of the lipid profile, were serum triglycerides, cholesterol, and LDL all decreased, while HDL increased with a *p-value* of 0.000 for each parameter as shown in (Table 6).

**Table 6:** Comparison between rate of change in the anthropometric measurements of both groups after 3 months.

| % change | | Group 1 | Group 2 | Test value• | *P-value* |
|---|---|---|---|---|---|
| | | No. = | No. = | | |
| S.HDL | Mean ± SD | 19.85 ± 6.03 | 1.15 ± 2.07 | -5.365 | **0.000** |
| | Range | 2.27 – 28.13 | 0 – 7.5 | | |
| S.LDL | Mean ± SD | -12.38 ± 2.46 | 0.74 ± 1.93 | -5.424 | **0.000** |
| | Range | -16.67 – -7 | -3.36 – 4.88 | | |
| S.Cholesterol | Mean ± SD | -8.74 ± 3.54 | 0.11 ± 1.56 | -4.773 | **0.000** |
| | Range | -13.33 – 1.75 | -3.91 – 2.35 | | |
| S.Triglyceride | Mean ± SD | -10.82 ± 2.02 | 0.87 ± 2.90 | -5.419 | **0.000** |
| | Range | -14.29 – -5.13 | -5.1 – 7.5 | | |

Note: $p < 0.05$: Significant (Bold)
HDL, high density lipoprotein, LDL, low density lipoprotein, •: Independent t-test

## DISCUSSION

Early life malnutrition has been linked to metabolic derangements including dyslipidemia [15]. Honey was found to adjust lipid profile, and cholesterol level in particular[16].

The present study demonstrated an increase in weight, height, and BMI measurements across the studied cohorts. However, a statistically significant difference in the rate of change was observed, with the honey-supplemented group exhibiting a significantly greater increase.

The result of the current study goes along with those of ***Harmiyati et al.*** who studied pediatric patients with malnutrition and found a significant difference between those who received honey and the control group in term of weight, height, and weight-for-height [17]. Furthermore, our findings align with those of ***Mohamed et al***. who discovered a notable improvement in the anthropometric measurements in pediatric patients with malnutrition after 8 weeks of honey supplementation [18].

Conversely, the study by ***Abdelrahman et al***. did not show any significant discrepancy in anthropometric measurements between the honey supplemented and un supplemented groups, which may be due to the short duration of the study, which was only two weeks [2].

Concerning the lipid profile, our findings revealed statistically significant difference in the rate of decrease of serum triglycerides, LDL, and cholesterol between group 1 and group 2, also the rate of increase of HDL was significantly higher in group 1. These findings are in accordance with a systematic review done by ***Alkhalifah et al*** who concluded that total cholesterol as well as LDL, and triglycerides were decreased significantly, while HDL showed significant increase with the intake of natural honey[19]. Another metanalysis showed similar results where honey supplementation had positive effects on lipid profile on both health and disease [20] .Furthermore, previous study stated that daily consumption of 70g of honey for a month reduced triglycerides, cholesterol, and LDL in dyslipidemic patients with comparable effects in non-dyslipidemic individuals, however these results wasn't statistically significant [21]. Another experimental study done on mice supported the hypolipidemic effect of honey [22].

In contrast to the current study, a systematic review and meta-analysis done by ***Gholami et al*** concluded that that honey had no significant effects on Total cholesterol, triglycerides, LDL, and HDL.[23] This discrepancy in results may be attributed to the diversity in methodologies, intervention durations, subject ages, and underlying health conditions.

The study's potential limitations include the restricted population sample size that may limit the generalizability of the findings. Thus, further studies with larger sample sizes are still required.

## CONCLUSION

Our study revealed that honey consumption had a profoundly beneficial impact on nutritional status, as evidenced by improvements in weight, height, and body mass index. Additionally, it favorably lowered fasting serum cholesterol, triglycerides, and LDL and increased serum HDL. These findings suggest that honey could be a cost-effective strategy for addressing malnutrition, especially in resource-constrained settings.

## CONFLICT OF INTEREST

All the authors declare that they have no conflicts of interest related to this Work and have no personal or financial relationships that could influence the work.

This work received no financial aid.

## AUTHORS' CONTRIBUTION

Mamdouh Abdelmaksod Abdulrahman: Conceptualization, Methodology, Data curation, Writing-Original draft preparation, Supervision, Validation,

Resources, Project administration. Marwa Salah Elsherif: Conceptualization, Methodology, Data curation, Validation, Writing- Reviewing and Editing. Nagwa Ibrahim Mohammed: Conceptualization, Methodology, Data curation, Investigation, Formal analysis, Writing-Original draft preparation Writing- Reviewing and Editing. Bassma Abdelnasser Abdelhaleem: Conceptualization, Methodology, Data curation, Formal analysis, Supervision, Validation, Writing- Original draft preparation Writing-Reviewing and Editing. All authors approved the final version of the manuscript.

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# الفوائد الغذائية لمكملات عسل البرسيم في الأطفال الذين يعانون من سوء التغذية: التأثيرات على النمو ومستويات الدهون

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**المقدمة:** في السياق المصري، يُعد سوء التغذية مشكلة صحية كبيرة تؤثر على نمو وتطور الأطفال. وسوء التغذية المزمن له تأثير ضار على الوظائف الأيضية في الجسم، مما يؤدي إلى اضطرابات أيضية متعددة. ومن بين هذه الاضطرابات، تم تحديد اضطراب الدهون في الدم كمشكلة بارزة.

**الهدف:** هدفت الدراسة إلى فحص الفوائد المحتملة لعسل البرسيم على النمو والأيض الدهني لدى الرضع والأطفال الذين يعانون من سوء التغذية.

**الطرق:** أجريت هذه الدراسة التجريبية المستقبلية العشوائية على ٤٠ رضيعًا وطفلًا يعانون من سوء التغذية، وتم تقسيمهم إلى مجموعتين متساويتين: المجموعة (أ) تلقت العسل بجرعة ١,٧٥ مل / كغ / يوم بالإضافة إلى التدخل التغذوي الموصى به من قبل منظمة الصحة العالمية لمدة ١٢ أسبوعًا، والمجموعة (ب) تلقت فقط التدخل التغذوي الموصى به من قبل منظمة الصحة العالمية. تم قياس القياسات الأنثروبومترية ومستويات الدهون بالدم بعد في بداية الدراسة وبعد ٣ أشهر.

**النتائج:** لوحظ تباين ذو دلالة إحصائية في معدل التغيير بين المجموعتين فيما يتعلق بالوزن والطول ومؤشر كتلة الجسم. كانت قيمة p لجميع المتغيرات الثلاثة ٠,٠٠٠، مما يشير إلى مستوى عالٍ من الدلالة الإحصائية. كما لوحظت نتائج مماثلة فيما يتعلق بمعدل التغيير في نسبة الدهون في الدم. فقد انخفضت الدهون الثلاثية والكوليسترول والكوليسترول الضار، بينما زاد الكوليسترول الجيد. كانت قيمة p لجميع المتغيرات الأربعة ٠,٠٠٠.

**الاستنتاجات:** أدى استهلاك العسل إلى تحسن كبير في الحالة التغذوية وخفض مستوى الدهون في الدم، مما يجعله حلًا واعدًا لمعالجة سوء التغذية في البلدان منخفضة الدخل.