International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Research Article

Effect Of Medium-Chain Triglyceride Oil Massage On Postnatal Weight Gain In Term And Late Preterm Neonates: A Randomized Controlled Trial

Dr. Vinay V. Kulkarni[1]*, Dr. Mohammed Mateen[2], Dr. Indira Bai N[3], Dr. Ayesha Jabeen[2]

[1]Department of Neonatology, Nice Hospital for Women and Children, Hyderabad, Telangana, India.
[2]Department of Pediatrics, Muslim Maternity and Children's Hospital, Hyderabad, Telangana, India.
[3]Department of Neonatology, Ankura Hospital for Women and Children - LB Nagar, Hyderabad, Telangana, India

OPEN ACCESS

Corresponding Author:

Dr. Vinay V. Kulkarni
MD, DM, Department of Neonatology, Nice Hospital for Women and Children, Hyderabad, Telangana, India.

Received: 21-08-2025
Accepted: 22-09-2025
Available online: 30-09-2025

ABSTRACT

Background: Topical oil massage is a traditional neonatal care practice. While both coconut oil and medium-chain triglyceride (MCT) oil have shown individual benefits, no prior randomized controlled trial has compared their efficacy in Indian neonates.
Objective: To evaluate the comparative effects of MCT oil versus coconut oil massage on postnatal weight gain in term and late preterm neonates over eight weeks in Indian settings.
Methods: A double-blind randomized controlled trial was conducted among term and late preterm neonates at a single center. Participants were randomized to receive daily massages with either MCT oil or coconut oil for eight weeks. The primary outcome was weight gain from baseline to week 8.
Results: A total of 200 neonates (term and late preterm) were randomized to receive daily body massage using either MCT oil (n=105) or coconut oil (n=95). Both groups showed progressive weight gain; however, the MCT group showed significantly greater mean weight gain from week 3 onwards. At week 6, the MCT group had a mean weight of 4.82 kg vs. 4.58 kg in the coconut oil group ($p<0.001$; Cohen's $d=0.81$). Adjusted weight gain from week 2 to week 8 was also significantly higher in the MCT group (1.39 kg vs. 1.26 kg, $p=0.006$). Subgroup analysis showed that late preterm neonates in the MCT group also experienced significantly greater weight gain, with the largest effect observed at week 6 (Cohen's $d=0.82$). No serious adverse events were reported. Compliance exceeded 90% in both groups.
Conclusion: MCT oil massage significantly enhances weight gain in neonates and may be considered a safe, effective, and culturally acceptable strategy in newborn care protocols.

***Keywords**: Infant massage, MCT oil, Neonatal growth, Neonatal nutrition, Postnatal weight gain, Preterm infant.*

INTRODUCTION

Low birth weight (LBW), defined as a birth weight less than 2500 grams, remains a major public health concern in India and South Asia, where it affects an estimated 26.4% of newborns and significantly increases the risk of neonatal mortality and long-term morbidity.[1] In particular, term and late preterm neonates with suboptimal birth weight face a higher risk of poor thermoregulation, infections, neurodevelopmental delays, and extended hospitalization.[2,3] Promoting adequate postnatal weight gain during the neonatal period is therefore essential for improving short- and long-term health outcomes.[1,2]

Topical oil massage is a culturally rooted, cost-effective, and widely practiced neonatal care intervention across South Asia, traditionally believed to promote warmth, strengthen bones, and support growth.[4,5] Emerging clinical evidence supports these beliefs, with studies demonstrating that neonatal massage improves weight gain, enhances skin barrier function, reduces transepidermal water loss, and stimulates vagal activity, thereby aiding digestion and overall development.[6,7] Neonatal skin, especially in preterm infants, is structurally immature, more permeable, thinner, and lacking complete lipid barriers. Biocompatible oils may also offer occlusive protection and serve as nutritional adjuncts via transcutaneous absorption of essential fatty acids.[3,8] A meta-analysis of 15 trials involving 697 infants found that moderate-pressure massage increased daily weight gain by approximately 5 grams compared to controls.[4] Indian studies have also reported that massage using natural oils improves growth metrics compared to mineral oil or no treatment [5,9]

Coconut oil is the most commonly used massage oil in Indian households due to its local availability, cultural acceptance, and beneficial properties. It is rich in lauric acid and has demonstrated moisturizing, antimicrobial, and thermoregulatory effects.[6,10] Experimental studies suggest that fatty acids from coconut oil can be absorbed through the immature neonatal skin, potentially contributing to caloric intake.[10] These properties make coconut oil a favorable choice for traditional neonatal massage.[6] Medium-chain triglyceride (MCT) oil, composed primarily of caprylic (C8) and capric (C10) acids, has also gained attention for its potential in neonatal nutrition. MCTs are more readily absorbed than long-chain fats and do not require bile salts or pancreatic enzymes, making them especially suitable for infants with immature digestive systems.[11] MCT oil is already used in specialized neonatal feeds due to its superior fat and nitrogen absorption profile.[11] In a randomized trial, preterm infants massaged with MCT oil demonstrated significantly greater weight gain within the first week compared to those who received no oil massage.[12]

While both coconut and MCT oils have individually demonstrated benefits for neonatal growth, no study has directly compared their efficacy when used for topical massage in Indian newborns. Given the differences in lipid composition and dermal absorption characteristics, such a comparison is important to inform evidence-based recommendations for neonatal care in home settings.[3,5,13] This randomized controlled trial was designed to address this gap by comparing the efficacy of MCT oil versus coconut oil massage in promoting postnatal weight gain among term and late preterm neonates in India over the first eight weeks of life. We hypothesized that MCT oil, due to its superior dermal absorption and caloric efficiency, would result in greater weight gain than coconut oil. In addition, the study assessed the safety, tolerability, acceptability, and potential secondary effects of both oils on skin health, feeding, and sleep behaviors.

METHODS

Study design and setting

This was a prospective, double-blind, randomized controlled trial conducted at the Muslim Maternity and Children's Hospital, located in Chaderghat, Hyderabad, India. The trial was conducted over a 12-month period from January 1, 2024, to December 31, 2024.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Muslim Maternity and Children's Hospital, Hyderabad and was was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki (2013 revision), Indian Council of Medical Research (ICMR) National Ethical Guidelines (2017), and the guidelines of Good Clinical Practice (GCP). The study was registered with the Clinical Trials Registry of India (CTRI; registration number: 2024/06/086780) prior to participant recruitment. The trial was reported in accordance with the CONSORT guidelines for randomized controlled trials.

Written informed consent was obtained from all parents or legal guardians of participating neonates before enrollment. All data were anonymized and stored securely, with access restricted to the research team to ensure confidentiality and privacy.

Study Participants

A total of 200 neonates were enrolled and stratified equally into two gestational age categories: term neonates (born between $37^{0}/_{7}$ and $41^{6}/_{7}$ weeks of gestation) and late preterm neonates (born between $34^{0}/_{7}$ and $36^{6}/_{7}$ weeks). Within each stratum, neonates were randomized in a 1:1 ratio to receive either MCT oil massage or coconut oil massage. Inclusion criteria comprised neonates born between $34^{0}/_{7}$ and $41^{6}/_{7}$ weeks of gestational age with appropriate birth weight for gestational age (AGA), who were hemodynamically stable within the first 48 hours of life, and for whom written parental consent was obtained. Neonates were excluded if they had major congenital malformations, required intensive care for more than 48 hours post-birth, exhibited cutaneous infections or dermatitis, or had a known hypersensitivity to oil-based products.

Sample Size Calculation

The sample size was calculated based on the primary outcome measure of mean weight gain (in grams) over eight weeks. Drawing from pilot data and published literature in similar neonatal populations, the expected mean weight gain in the coconut oil group was estimated at 3000 grams, with a standard deviation of 600 grams. A mean difference of 250 grams was considered clinically significant. Assuming a two-sided significance level of 5% (α = 0.05) and 80% power (β = 0.20), the sample size required per group was 91 neonates. The calculation was based on the formula for comparing two independent means:

$n = ((Z_{a}/_{2} + Z_{\beta}) / (\Delta / \sigma))^2 \times 2$

Where $Z_{\alpha/2}$=1.96 for 95% confidence, Z_{β}=0.84 for 80% power, Δ=250 grams (expected difference), and σ=600 grams (standard deviation).

After adjusting for an anticipated attrition rate of 10%, the final sample size was increased to 100 neonates per group, leading to a total sample size of 200 neonates. Stratified randomization ensured equal representation of term and late preterm neonates across both intervention arms.

Randomization and Blinding

Eligible neonates were randomized using a stratified block randomization technique. Stratification was based on gestational age, with separate blocks for term and late preterm neonates. A computer-generated randomization sequence, prepared by an independent statistician, was used to assign participants in blocks of varying sizes (4, 6, and 8) to either the MCT oil or coconut oil massage group. Allocation concealment was ensured through the use of opaque, sealed envelopes, color-coded by gestational category (red for term, yellow for late preterm), which were opened sequentially upon enrollment. The MCT oil used in the study was 'NiQu CT Oil' manufactured by NeoWinn Biotech (caprylic acid to capric acid ratio of 70:30, while the coconut oil used was from Dr. Gold. Both oils were bulk-filled directly from their original containers following strict hygienic protocols to ensure quality and safety.

Blinding was rigorously maintained at multiple levels. Caregivers administering the massage, outcome assessors recording the neonates' weights, and the statistical analysts were all blinded to group assignment. Both MCT oil and coconut oil were dispensed in identical, opaque, white bottles labeled only with randomization codes. The physical properties of the two oils, including viscosity, color, and scent, were closely matched to prevent perceptual bias. Preparation and labeling of the intervention bottles were performed solely by the corresponding investigator, who maintained the master randomization list in a password-protected file inaccessible to other study personnel until data analysis.

Intervention Protocol

Neonates began receiving the intervention within the first 48 hours of life. The assigned oil (10 mL per session) was applied via gentle massage once daily for eight weeks. Massage was performed by trained caregivers for a minimum duration of 10 to 15 minutes and covered the entire body except the face and scalp. Adherence to the massage protocol was recorded in printed logbooks maintained by the caregivers.

Outcomes Measures

Baseline data were recorded for all neonates at the time of enrollment. This included demographic and clinical information such as sex, gestational age, birth weight, type of feeding initiated, categorized as direct breastfeeding (DBF)/mixed feeding/or formula feeding. In addition, size for gestational age was also recorded, which was classified as small for gestational age (SGA)/ appropriate for gestational age (AGA)/or large for gestational age (LGA). The primary outcome of the study was the mean weight gain (in grams) from baseline (birth) to the end of eight weeks. Secondary outcomes included the incidence of local adverse skin reactions such as erythema, rash, or skin breakdown; caregiver-reported acceptability and compliance with the massage regimen (assessed at weeks 4 and 8); and qualitative maternal reports on neonatal feeding behavior and sleep patterns collected during weekly follow-up visits.

Statistical analysis

All data were entered into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables, such as weight and weight gain, were summarized using means and standard deviations (SD) or medians with interquartile ranges (IQR) where appropriate, based on normality testing using the Shapiro-Wilk test. Categorical variables, including sex, type of feeding, and adverse skin reactions, were expressed as frequencies and percentages.

For the primary outcome, mean weight gain over eight weeks, comparisons between the MCT oil and coconut oil groups were performed using the independent samples t-test for normally distributed data or the Mann-Whitney U test for non-normally distributed data. Weekly weight differences were also compared at each time point using similar methods. Repeated measures were analyzed using mixed-effects models with group, time, and group × time interaction as fixed effects, and individual neonate as a random effect, to account for intra-subject correlation over time.

Subgroup analyses were pre-specified for term vs. late preterm neonates, and similar statistical tests were applied within each subgroup to evaluate differential effects of the intervention. Categorical variables were compared using the Chi-square test or Fisher's exact test as appropriate. All analyses were conducted on an intention-to-treat basis. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

Participant Flow and Baseline Characteristics

A total of 200 neonates were enrolled and randomized into two groups to receive MCT oil massage (n=105) or coconut oil massage (n=95). The participants were equally stratified by gestational age, with 101 (50.5%) categorized as late preterm and 99 (49.5%) as term neonates. The distribution between intervention arms was balanced within each stratum, with 51 late preterm and 54 term neonates in the MCT group, and 50 late preterm and 45 term neonates in the coconut oil group. Figure 1 shows the flow of participants in the study.

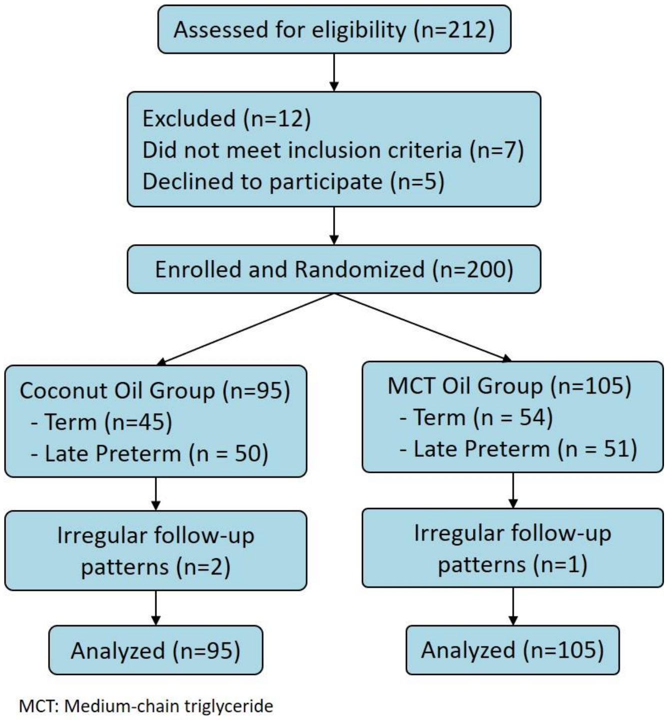

Figure 1: Flow diagram

Baseline demographic and clinical characteristics of the enrolled neonates were comparable between the MCT oil and coconut oil groups, demonstrating effective randomization. No statistically significant differences were observed between groups in terms of gestational age (Figure 2) (p = 0.273), sex distribution (p = 0.804), feeding pattern at enrollment (p = 0.313), classification by size for gestational age (SGA, AGA, or LGA) (p = 0.832), or birth weight (p = 0.220). All p-values exceeded the standard 0.05 threshold for statistical significance (all p>0.05), and the corresponding effect sizes, Cohen's d for continuous variables and Cramér's V for categorical comparisons, were uniformly small or negligible (**Table 1**).

Table 1: Baseline demography and clinical characteristics of neonates by intervention groups

Variable	MCT Group (n = 105)	Coconut oil Group (n = 95)	Test Type	p- value	Effect Size
Gestational Age (weeks)	37.37 ±2.02	37.07 ± 1.93	Independent t-test	0.273	*d* = 0.16 (very small)*
Sex (Male %)	56 (53.3%)	49 (51.6%)	Chi-square test	0.804	Cramér's V=0.02 (negligible)
Feeding Pattern					
DBF	12	16	Chi-square test (3x2)	0.313	Cramér's V=0.11 (small)
Formula	26	28			
Mixed	67	51			
Size for gestational age					
SGA	2	3	Chi-square test (3x2)	0.832	Cramér's V=0.04 (negligible)
AGA	85	77			
LGA	18	15			
Birth Weight (kg)	2.85 ± 0.37	2.78 ± 0.40	Independent t-test	0.22	*d* = 0.17 (very small)*

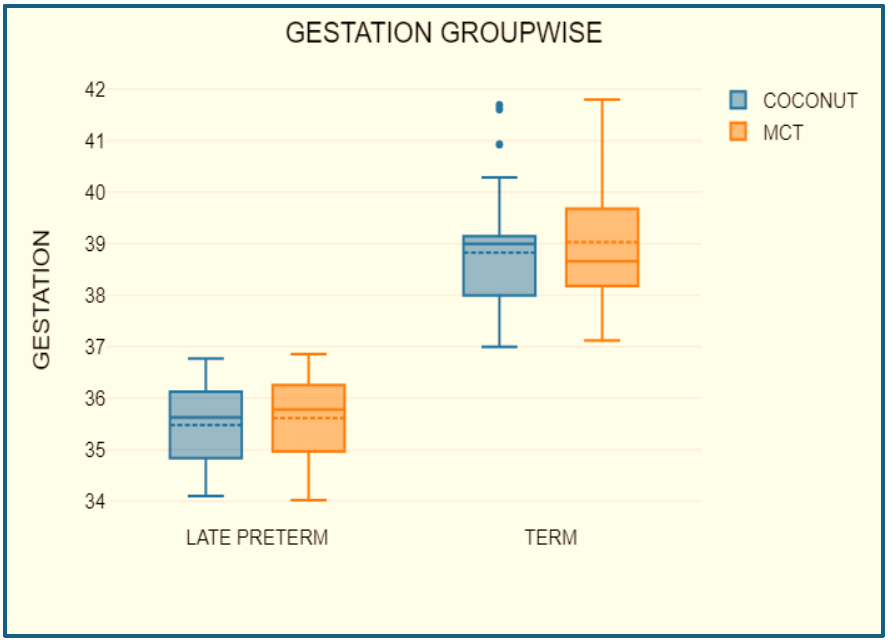

Figure 2. Distribution of Gestational Age in Both Groups

Box plot comparing gestational age (in weeks) among neonates enrolled in the MCT oil and coconut oil massage groups. The figure depicts the median, interquartile range, and outliers, demonstrating a comparable distribution of gestational age between the two groups with majority of infants in the late preterm and term range.

AGA: Appropriate for gestational age; DBF: Direct breastfeeding; LGA: Large for gestational age; MCT: Medium-chain triglyceride; SGA: Small for gestational age. *For both gestational age and birth weight, Levene's test p > 0.05, indicating equal variances, validating the use of t-tests with pooled variance.

Primary Outcome

Week-wise absolute weight gain

Both groups showed steady and progressive increases in weight over the 8-week follow-up period; however, neonates in the MCT oil group consistently exhibited greater mean weights from week 3 onwards (**Table 2**). By Week 4, the mean weight in the MCT group was significantly higher than that of the coconut oil group (p = 0.022), and the difference continued to become prominent through subsequent weeks in favor of the MCT group. The most pronounced difference was observed at Week 6, where the MCT group had a significantly higher mean weight compared to the coconut oil group (p < 0.001). (Figures 3 and 4)

Table 2: Weekly Body Weight Comparison Between MCT and Coconut Oil Groups

Week	Absolute Weekly Weights			Cumulative Weekly Weight Gain			
	MCT Group (Kg)	Coconut Oil Group (Kg)	p-value*	MCT Group (Kg)	Coconut Oil Group (Kg)	p-value#	Cohen's *d* (Effect Size)
Week 1	2.82 ± 0.37	2.76 ± 0.41	0.220	-0.01 ± 0.09	-0.02 ± 0.08	0.619	0.07
Week 2	3.03 ± 0.39	2.94 ± 0.42	0.228	0.19 ± 0.12	0.17 ± 0.10	0.088	0.24
Week 3	3.25 ± 0.40	3.12 ± 0.43	0.050	0.41 ± 0.15	0.35 ± 0.12	0.001	0.47
Week 4	3.48 ± 0.41	3.32 ± 0.44	0.022	0.64 ± 0.18	0.54 ± 0.14	<0.001	0.60
Week 5	3.70 ± 0.42	3.51 ± 0.44	0.001	0.86 ± 0.20	0.73 ± 0.16	<0.001	0.72
Week 6	3.92 ± 0.43	3.70 ± 0.46	<0.001	1.09 ± 0.21	0.92 ± 0.18	<0.001	0.81
Week 7	4.17 ± 0.50	3.93 ± 0.53	0.013	1.33 ± 0.30	1.15 ± 0.28	<0.001	0.61
Week 8	4.44 ± 0.51	4.15 ± 0.54	0.006	1.58 ± 0.31	1.37 ± 0.30	<0.001	0.71

Data presented as Mean ± SD. *Between-Group comparison with p-values derived from independent samples t-tests at each week. #p-values are from two-tailed t-tests assuming equal variances. *#A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

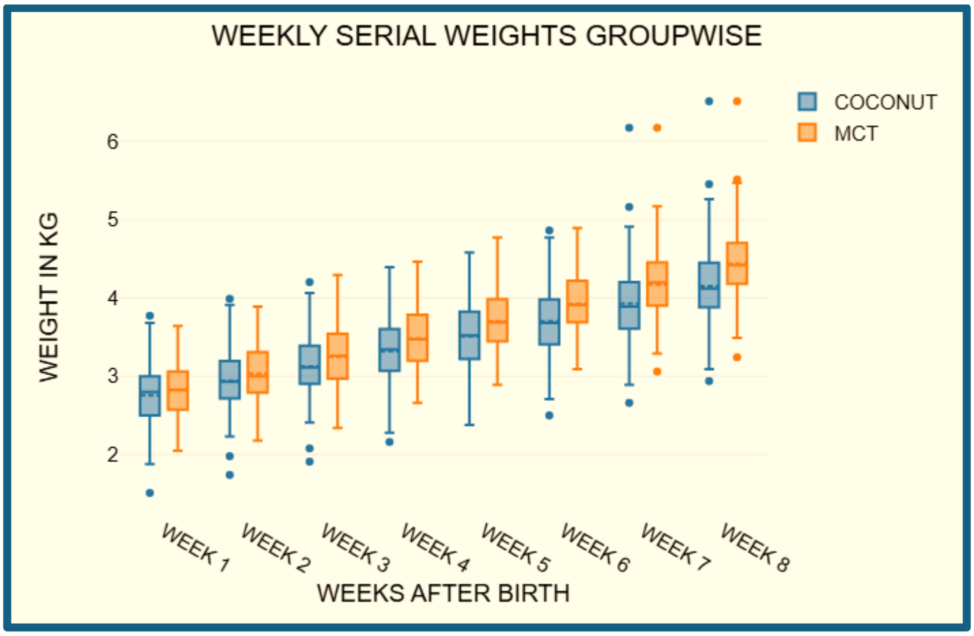

Figure 3. Weekly Serial Weight Distribution

Box plot illustrating the serial weights (in grams) of neonates from Week 1 to Week 8 in both MCT oil and coconut oil massage groups. Each weekly box shows the median weight, interquartile range, and range of values. This figure reflectsthe overall weight progression in both groups and highlights greater intergroup separation in later weeks.

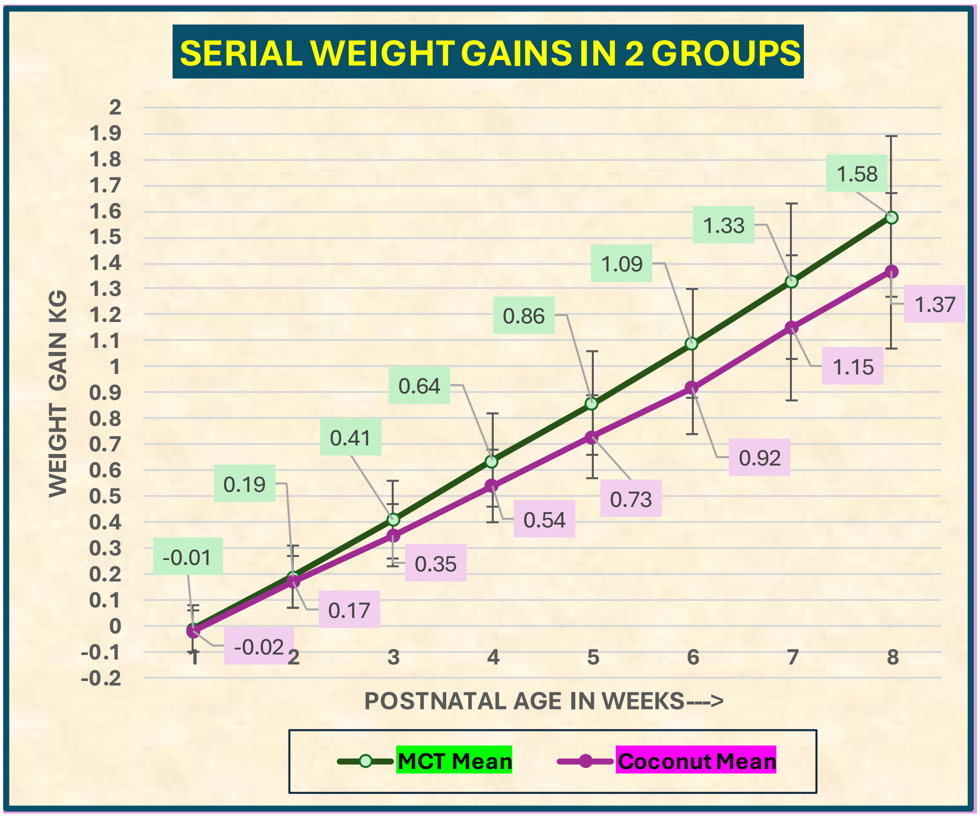

Figure 4. Mean Serial Weight Gain Trends in Two Groups

Line graph representing the trend of mean weekly weight gain (delta weight) over 8 weeks of follow-up. The x-axis denotes postnatal weeks (Week 1 to Week 8), and the y-axis represents mean weight gain in grams. The MCT oil group shows consistently higher weight gain, with a statistically significant difference observed particularly at Week 6 ($p = 0.003$), suggesting a potentially enhanced anabolic effect of MCT oil during this phase.

A two-way repeated measures ANOVA confirmed a statistically significant main effect of time ($p < 0.001$), group ($p = 0.005$), and a strong interaction effect between time and group ($p < 0.001$), indicating that the trajectory of weight gain differed meaningfully between groups, with the MCT group showing accelerated and sustained growth.

A statistically significant increase in weight gain was observed in the MCT group from Week 3 through Week 8 **(Table 2)**. The effect size of the intervention progressively increased over time, reaching its peak at Week 6 with a large effect size (Cohen's d = 0.81). In contrast, weight gain differences between groups during the initial two weeks were minimal and not statistically significant, indicating that the effects of the intervention became more pronounced over time.

Adjusted Weight Gain

To correct for physiological postnatal weight fluctuations, weight at week 2 was considered as the baseline for calculating adjusted weight-gains. From Week 2 onward, neonates in the MCT oil group consistently exhibited significantly greater weight gain compared to those in the coconut oil group **(Table 3)**. At Week 4, the difference was statistically significant ($p < 0.001$), with a medium effect size (Cohen's d = 0.76). This difference became more pronounced by Week 6, where a large effect size was observed (d = 0.92). The trend persisted at Week 8, with the MCT group maintaining a statistically significant advantage ($p = 0.006$) and a small but meaningful effect size (d = 0.39).

Table 3: Post-Week-2 Weight Gain (kg) Between Groups at Weeks 4, 6, and 8

Week	Group	Weight gain (kg)	t (df)	p-value*	95% CI	Cohen's *d*	Effect Size
Week 4	MCT	0.45 ±0.11	-5.36 (188.5)	<0.001	[-0.10, -0.04]	0.76	Medium
	Coconut oil	0.38 ±0.08					
Week 6	MCT	0.89 ±0.15	-6.48 (197)	<0.001	[-0.17, -0.09]	0.92	Large
	Coconut oil	0.76 ±0.14					
Week 8	MCT	1.46 ±0.60	-2.77 (198)	0.006	[-0.38, -0.06]	0.39	Small
	Coconut oil	1.23 ±0.53					

Data presented as Mean ±SD. *A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

Percentage Weight Gain

Percentage Weight Gain from Birth

No significant difference in percentage weight change was observed between groups at week 1 and Week 2, consistent with the expected physiological weight loss and stabilization phase in neonates. From Week 3 onward, the MCT group demonstrated consistently greater percentage weight gain compared to the coconut oil group, with statistically significant differences at each time point **(Table 4)**. This trend closely mirrored the pattern observed for absolute weight gain. Effect sizes increased progressively over time, starting as small as weeks 3 and 4, and reaching medium magnitude at Weeks 5 and 6, suggesting a cumulative benefit of MCT oil application. The greatest difference was noted at Week 6, where the MCT group showed a 38.84% weight gain versus 33.95% in the coconut oil group, highlighting both statistical and clinical relevance. While effect sizes returned to the small range at Weeks 7 and 8, the absolute differences in mean percentage weight gain remained clinically meaningful.

Table 4: Percentage Weight Gain from Birth Between Groups (Week 1 to 8)

Weeks	Group	Weight Gain (%)	t (df)	p-value*	95% CI	Cohen's *d*	Effect Size
Week 1	MCT	-0.47 ± 3.34	-0.62 (197)	0.536	[-1.16, 0.61]	0.09	Very small
	Coconut oil	-0.74 ± 2.92					
Week 2	MCT	6.91 ± 4.44	-1.38 (197)	0.168	[-1.99, 0.35]	0.20	Very small
	Coconut oil	6.09 ± 3.85					
Week 3	MCT	14.70 ± 5.87	-2.63 (197)	0.009	[-3.54, -0.50]	0.37	Small
	Coconut oil	12.69 ± 4.84					
Week 4	MCT	22.92 ± 7.13	-3.12 (197)	0.002	[-4.84, -1.08]	0.44	Small
	Coconut oil	19.96 ± 6.16					
Week 5	MCT	30.84 ± 8.11	-3.59 (197)	<0.001	[-6.03, -1.74]	0.51	Medium
	Coconut oil	26.95 ± 7.07					
Week 6	MCT	38.84 ± 9.13	-3.96 (197)	<0.001	[-7.33, -2.44]	0.56	Medium
	Coconut oil	33.95 ± 8.19					
Week 7	MCT	47.27 ±11.49	-3.34 (197)	0.001	[-8.32, -2.13]	0.47	Small
	Coconut oil	42.05 ±10.47					
Week 8	MCT	56.48 ±12.92	-3.47 (198)	0.001	[-9.80, - 2.67]	0.49	Small
	Coconut oil	50.25 ±12.45					

Data presented as Mean ±SD. *A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

Percentage Weight Gain from Week 2 Baseline

Percentage weight gain from week 2 to weeks 4, 6, and 8 was also significantly higher in the MCT oil group compared to the coconut oil group at all three intervals **(Table 5)**. The magnitude of divergence increased over time, indicating a sustained and cumulative benefit associated with MCT oil application. Effect sizes across these intervals were in the medium range (Cohen's d = 0.51-0.61), supporting both statistical significance and clinical relevance of the observed differences.

Table 5: Comparison of Percentage Weight Gain from Week 2 Baseline

Weeks	Group	Weight Gain (%)	t (df)	p- value*	95% CI	Effect Size (Cohen's *d*)	Effect Size
Week 4 vs 2	MCT	14.95 ±3.88	-3.73 (197)	<0.001	[-2.91, -0.89]	0.53	Medium
	Coconut oil	13.05 ± 3.24					
Week 6 vs 2	MCT	29.83 ± 5.96	-4.27 (197)	<0.001	[-5.25, -1.92]	0.61	Medium
	Coconut oil	26.25 ± 5.87					
Week 8 vs 2	MCT	46.36 ± 9.60	-3.61 (197)	<0.001	[-7.68, -2.24]	0.51	Medium
	Coconut oil	41.40 ± 9.75					

Data presented as Mean ±SD. *A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

Subgroup Analysis

Weekly weight gain from birth to 8 weeks in the late preterm neonates subgroup

In term neonates, the MCT oil group exhibited a consistent advantage in weight gain over the coconut oil group beginning in week 3. In late preterm neonates, who are more vulnerable to extrauterine growth restriction, early weight gain patterns were similar across both groups. However, significant differences were observed by week 6 **(Table 6)**. Among late preterm neonates, the MCT group demonstrated statistically significantly greater weight gain compared to the coconut oil group from Week 3 onward. In this subgroup, effect sizes increased progressively over time, transitioning from small to large, and peaking between Weeks 5 and 8. Notably, at Week 6, a large effect size was observed (Cohen's d=0.82), indicating a substantial and clinically meaningful benefit of MCT oil application.

Table 6: Weekly weight gain from birth to 8 weeks in late preterm neonates subgroup

Week	Group	Weight gain (kg)	t (df)	p-value	95% CI	Effect Size (Cohen's *d*)	Effect
Week 1	MCT	-0.01 ± 0.09	-0.50 (99)	0.618	[-0.04, 0.02]	0.10	Very small
	Coconut oil	-0.02 ± 0.08					
Week 2	MCT	0.19 ± 0.12	-1.21 (99)	0.228	[-0.07, 0.02]	0.24	Small
	Coconut oil	0.16 ± 0.10					
Week 3	MCT	0.39 ± 0.15	-1.98 (99)	0.050	[-0.10, 0.00]	0.39	Small
	Coconut oil	0.34 ± 0.11					
Week 4	MCT	0.61 ± 0.18	-2.33 (99)	0.022	[-0.14, -0.01]	0.46	Small
	Coconut oil	0.54 ± 0.14					
Week 5	MCT	0.84 ± 0.21	-3.44 (99)	0.001	[-0.19, -0.05]	0.68	Medium
	Coconut oil	0.71 ± 0.15					
Week 6	MCT	1.05 ± 0.22	-4.11 (99)	<0.001	[-0.24, -0.08]	0.82	Large
	Coconut oil	0.89 ± 0.17					
Week 7	MCT	1.30 ± 0.36	-2.52 (99)	0.013	[-0.31, -0.04]	0.50	Medium
	Coconut oil	1.13 ± 0.33					
Week 8	MCT	1.55 ± 0.35	-2.82 (99)	0.006	[-0.33, -0.06]	0.56	Medium
	Coconut oil	1.36 ± 0.33					

Data presented as Mean ± SD. *A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

Percentage weight gain from week 2 to weeks 4, 6, and 8 in late preterm neonates' subgroup

Among late preterm neonates, percentage weight gain from Week 2 to Week 4 was higher in the MCT group compared to the coconut oil group; however, the difference did not reach statistical significance (p=0.086). However, the effect size (Cohen's d=0.34) indicates a small potential effect. By Week 6, the MCT group exhibited significantly greater weight gain (p=0.003), with a moderate effect size (d=0.61), suggesting a meaningful clinical impact. This trend continued through Week 8, where the MCT group maintained significantly higher weight gain (p=0.032), accompanied by a small but meaningful effect size (d=0.43), indicating a sustained benefit of MCT oil on postnatal growth in this subgroup.

Table 7: Percentage weight gain from week 2 to weeks 4, 6, and 8 in late preterm neonates' subgroup

Week	Group	Weight gain (%)	t (df)	p-value*	95% CI	Effect Size (Cohen's *d*)	Effect
Week 4 vs 2	MCT	15.49 ±4.09	-1.73 (99)	0.086	[-2.84, 0.19]	0.34	Small
	Coconut oil	14.16 ±3.58					
Week 6 vs 2	MCT	31.69 ±6.52	-3.06 (99)	0.003	[-6.59, -1.40]	0.61	Medium
	Coconut oil	27.69 ±6.61					
Week 8 vs 2	MCT	49.17 ±10.44	-2.17 (99)	0.032	[-8.75, -0.39]	0.43	Small
	Coconut oil	44.60 ± 10.72					

Data presented as Mean ± SD. *A p-value of less than 0.05 was considered statistically significant. MCT: Medium-chain triglyceride.

Secondary Outcomes

Safety and Tolerability

No serious adverse events were reported in either group throughout the study period. Both MCT oil and coconut oil were well tolerated, with no instances requiring discontinuation of massage due to oil-related complications. Vital signs, thermoregulation, and overall clinical well-being remained stable across both groups, and no systemic adverse reactions were observed.

Local skin reactions were infrequent and mild. Transient erythema at the site of massage was noted in two neonates (2.1%) in the coconut oil group and three neonates (2.9%) in the MCT oil group. All cases resolved spontaneously within 24 to 48 hours without the need for medical intervention. Importantly, no cases of skin breakdown, peeling, dermatitis, rash, pruritus, or infection were recorded in either group. These findings support the safety and tolerability of both oils for routine use in neonatal massage.

Caregiver Acceptability and Compliance

Caregiver compliance was excellent in both groups. High massage adherence (>90% of scheduled sessions) was achieved by 93.7% of caregivers in the coconut oil group (89 out of 95) and 92.4% in the MCT oil group (97 out of 105). All caregivers received standardized training through demonstrations at enrollment, and weekly follow-ups by health staff confirmed ongoing adherence. No caregivers declined their assigned oil after randomization, and all were able to perform the oil massage correctly under supervision following initial instruction. There were no dropouts attributed to refusal to apply the oils. Subjective feedback from caregivers indicated high acceptability of both oils. Commonly cited factors supporting continued use included ease of application, pleasant texture and scent, and perceived improvements in infant behavior.

Ancillary Observations on Feeding and Sleep

Caregivers in both groups informally reported perceived improvements in infant feeding and sleep patterns, particularly after the third week of intervention. Increased feeding demand was noted more frequently in the MCT oil group, with 42 caregivers (40%) informally reporting greater appetite or more frequent feeding. Improvements in night-time sleep were mentioned by caregivers in both groups, with slightly higher reporting in the MCT group (47 caregivers, 44.7%) compared to the coconut oil group (39 caregivers, 41.0%). These subjective reports, though not formally quantified, suggest potential additional benefits of oil massage as perceived by caregivers, particularly in the MCT oil group.

DISCUSSION

This double-blind randomized controlled trial was designed to evaluate the comparative effects of MCT oil and coconut oil massage on postnatal weight gain in term and late preterm neonates. The findings clearly demonstrate that MCT oil massage was superior to coconut oil in promoting weight gain across all postnatal weeks of observation. The strong baseline comparability between the two groups ensured that observed differences in outcomes could be primarily attributed to the massage intervention, rather than underlying demographic or clinical disparities.

Our findings demonstrated that massage with MCT oil resulted in significantly greater weight gain than coconut oil massage, with differences becoming statistically significant by the third week and peaking by the sixth week of life. These findings suggest a sustained anabolic benefit of MCT oil during a critical window of neonatal growth. The superior performance of MCT oil aligns with prior hypotheses and clinical evidence. Saeadi et al. demonstrated that MCT oil massage significantly improves weight gain in preterm infants, attributing this to the small molecular size and high lipid solubility of caprylic (C8) and capric (C10) acids, which enhance dermal absorption and energy availability.[14] A study by Liao et al. also showed that daily massage with MCT oil is an effective intervention for promoting weight gain in preterm infants and should be integrated into developmental care for low-birth-weight infants.[12] In contrast, although coconut oil is rich in lauric acid and widely accepted for its moisturizing and antimicrobial effects, its higher molecular weight and viscosity may hinder effective transdermal penetration.[5,15] In line with the findings of studies by Saeadi et al. and Liao et al., subgroup analysis in our study also highlighted the value of MCT oil in late preterm infants, who are particularly vulnerable to extrauterine growth restriction. Between Weeks 2 and 6, weight gain in the MCT group was significantly greater than in the coconut oil group. This subgroup analysis reinforced that the anabolic advantage of MCT oil extends to the more vulnerable late preterm population, especially after the early adaptation period when enteral feeding stabilizes and metabolic demands increase.

Our results are consistent with clinical evidence showing that oil massage enhances neonatal growth. Studies have shown that oil massage can be a safe and effective intervention to promote weight gain in LBW preterm neonates.[16,17] Indian trials also have shown that coconut oil massage improves weight gain velocity relative to no treatment or mineral oil.[5,9] In the current study, even the coconut oil group showed robust growth (nearly 380 g over two weeks), reinforcing the efficacy of traditional massage practices. However, MCT oil provided an additional nearly 40 g of weight gain over the same period (nearly 10% higher), translating to an extra nearly 3 g/day, consistent with the presumed incremental caloric contribution. Evidence of systemic absorption of massage oils also supports our findings. Solanki et al. reported elevated serum lipid levels in neonates following coconut oil massage, indicating that fatty acids can cross the skin barrier and enter circulation.[9] This transdermal nutrient uptake is likely even more efficient with MCT oil due to its physicochemical properties and lower molecular weight.[9] Interestingly, our results contrast somewhat with a study by Sana et al., which found no significant difference between MCT and coconut oil massage in low-birth-weight infants.[18] However, differences in population characteristics (e.g., gestational age, birth setting), oil composition, and massage protocols may explain these discrepancies. Our study focused specifically on term and late preterm Indian neonates and showed that even modest differences in oil properties can produce meaningful gains when applied systematically over time.

The enhanced efficacy of MCT oil may be attributed to several physiologic and biochemical mechanisms. First, MCTs are uniquely metabolized; they bypass lymphatic absorption and enter the portal circulation directly, where they are rapidly oxidized in the liver without requiring bile salts or micellar transport.[1] This metabolic pathway is particularly beneficial in neonates, whose digestive enzymes and bile salt production are still immature. Second, the improved bioavailability of MCT oil is supported by its dermal characteristics. MCT oils are rich in caprylic and capric acids, which offer advantages over conventional oils due to their low molecular weight, high lipid solubility, and enhanced skin penetration, properties that are especially relevant given the immature stratum corneum in neonates.[3,6] The onset of statistically significant weight differences around week 3 corresponds with the maturation of the skin barrier, which may allow for more effective transdermal nutrient retention.[8] Additionally, both MCT and coconut oils exert emollient effects, reduce transepidermal water loss, and support skin barrier function.[6,7] Massage itself enhances vagal tone, insulin secretion, gastrointestinal motility, and nutrient absorption.[2,3] Studies have shown that a related increase in vagal activity is one of the mechanisms of increased weight gain associated with message.[19] These benefits of the message may be further potentiated when combined with energy-rich oils like MCT.

In our study, the massage intervention was highly accepted by caregivers across both groups, with excellent compliance. This was likely facilitated by standardized demonstrations, weekly follow-ups, and the cultural integration of oil massage in Indian households. Importantly, both oils showed excellent safety profiles, with only a few minor and self-limiting skin reactions reported. Though not a prespecified outcome, caregivers frequently noted improvements in infant feeding and sleep patterns, particularly after the third week. These anecdotal benefits may be reflective of the neurohormonal effects of massage and the improved energy status provided by MCT oil, which is consistent with previous findings on massage-related stress modulation and HPA axis regulation.[3] Previous studies have also shown that caregivers are always willing to modify traditional practices of topical massage, which support positive health outcomes.[20]

Clinical Implications

This trial provides robust clinical evidence supporting the use of MCT oil massage to promote postnatal weight gain in both term and late preterm neonates. Findings of this study support a broader applicability of MCT oil without the need for gestation-specific adaptations. MCT oil may play a critical role in postnatal nutritional support, particularly in neonates at risk for suboptimal growth. Its safety, ease of application, and cultural compatibility further support its scale-up in public health initiatives. These findings have potential implications for nutritional protocols in neonatal wards, community health programs, and home-based newborn care.

Strengths and Limitations of Study

This study has several strengths. This was a double-blind randomized controlled trial with stratified block randomization, minimizing bias and ensuring balanced group allocation. Standardized intervention protocols, blinding integrity through identical oil packaging, and consistent caregiver training enhanced internal validity. Inclusion of both term and late preterm neonates adds clinical relevance, especially in the Indian context. Weekly follow-up over eight weeks allowed for identification of growth trends, and photographic verification of weight recordings ensured data authenticity. High participant retention and caregiver compliance further highlighted the real-world feasibility and acceptability of the intervention. However, this study also has some limitations. The relatively short follow-up period limited the ability to assess long-term outcomes, including linear growth and neurodevelopment. Mechanistic insights were constrained by the absence of biochemical or hormonal assessments, and no objective measurements of skin barrier function were performed. Potential confounding factors, such as variations in parental care, feeding patterns, or home hygiene practices, were not quantitatively controlled. Finally, the single-center design and the relatively homogeneous study population may limit the generalizability of the findings to other regions or healthcare settings with different practices or demographics.

CONCLUSION

This randomized controlled trial demonstrated that daily massage with MCT oil results in significantly greater postnatal weight gain compared to coconut oil in both term and late preterm neonates over an 8-week period. The benefits were particularly evident from the third week of life and were sustained through week eight. Importantly, the intervention was well-tolerated, safe, and highly acceptable to caregivers, with no serious adverse events reported. These findings support the clinical adoption of MCT oil massage as a simple, culturally appropriate, and effective strategy to promote early neonatal growth, especially in resource-limited or home-care settings. Future studies should explore long-term effects on growth and neurodevelopment, as well as biochemical mechanisms underlying the observed benefits.

Funding: No funding sources
Conflict of interest: None declared

REFERENCES

1. Singh D, Manna S, Barik M, Rehman T, Kanungo S, Pati S. Prevalence and correlates of low birth weight in India: findings from national family health survey 5. BMC Pregnancy and Childbirth. 2023 Jun 20;23(1):456.
2. Field T, Diego M, Hernandez-Reif M. Preterm Infant Massage Therapy Research: A Review. Infant Behav Dev. 2010 Apr;33(2):115–24.
3. Visscher MO, Summers A, Narendran V, Khatry S, Sherchand J, LeClerq S, et al. Birthweight and Environmental Conditions Impact Skin Barrier Adaptation in Neonates Receiving Natural Oil Massage. Biomed Hub. 2021 Jan 18;6(1):17–34.
4. Lu LC, Lan SH, Hsieh YP, Lin LY, Chen JC, Lan SJ. Massage therapy for weight gain in preterm neonates: A systematic review and meta-analysis of randomized controlled trials. Complement Ther Clin Pract. 2020 May;39:101168.
5. Sankaranarayanan K, Mondkar JA, Chauhan MM, Mascarenhas BM, Mainkar AR, Salvi RY. Oil massage in neonates: an open randomized controlled study of coconut versus mineral oil. Indian Pediatr. 2005 Sep;42(9):877–84.
6. Aksucu G, Azak M, Çağlar S. Effects of Topical Oils on Neonatal Skin: A Systematic Review. Adv Skin Wound Care. 2022 Dec 1;35(12):1–9.
7. Oranges T, Dini V, Romanelli M. Skin Physiology of the Neonate and Infant: Clinical Implications. Adv Wound Care (New Rochelle). 2015 Oct 1;4(10):587–95.
8. Anić Jurica S, Colic A, Gveric-Ahmetasevic S, Loncarevic D, Filipovic-Grcic B, Stipanovic-Kastelic J, et al. Skin of the very premature newborn – physiology and care. Paediatr Croat. 2016 Mar 25;60(1):21–6.
9. Mohini M, Jaipal ML, Bisht SS, Tyagi A. A randomised comparative study of coconut oil massage for effect on weight change in low birth weight neonates. International Journal of Contemporary Pediatrics. 2021 Aug 23;8(9):1575–80.
10. Solanki K, Matnani M, Kale M, Joshi K, Bavdekar A, Bhave S, et al. Transcutaneous absorption of topically massaged oil in neonates. Indian Pediatr. 2005 Oct;42(10):998–1005.
11. Tantibhedhyangkul P, Hashim SA. Medium-chain triglyceride feeding in premature infants: effects on fat and nitrogen absorption. Pediatrics. 1975 Mar;55(3):359–70.
12. Liao YC, Wan YH, Chen PH, Hsieh LY. Efficacy of medium-chain triglyceride oil massage on growth in preterm infants: a randomized controlled trial: A CONSORT-compliant article. Medicine (Baltimore). 2021 Jul 30;100(30):e26794.
13. Summers A, Visscher MO, Khatry SK, Sherchand JB, LeClerq SC, Katz J, et al. Impact of sunflower seed oil versus mustard seed oil on skin barrier function in newborns: a community-based, cluster-randomized trial. BMC Pediatr. 2019 Dec 23;19:512.
14. Saeadi R, Ghorbani Z, Shapouri Moghaddam A. The effect of massage with medium-chain triglyceride oil on weight gain in premature neonates. Acta Med Iran. 2015;53(2):134–8.
15. Arora J, Kumar A, Ramji S. Effect of oil massage on growth and neurobehavior in very low birth weight preterm neonates. Indian Pediatr. 2005 Nov;42(11):1092–100.
16. Fallah R, Akhavan Karbasi S, Golestan M, Fromandi M. Sunflower oil versus no oil moderate pressure massage leads to greater increases in weight in preterm neonates who are low birth weight. Early Hum Dev. 2013 Sep;89(9):769–72.
17. Kumar J, Upadhyay A, Dwivedi AK, Gothwal S, Jaiswal V, Aggarwal S. Effect of oil massage on growth in preterm neonates less than 1800 g: a randomized control trial. Indian J Pediatr. 2013 Jun;80(6):465–9.
18. Sana, Nawaz N, Yazdani A, Nazar M, Jabeen A, Ameer R. Effect of coconut oil versus medium chain triglyceride oil massage on weight gain in low birth weight newborns: a randomized controlled trial. The Research of Medical Science Review. 2025 Jan 1;3(1):308–13.
19. Diego MA, Field T, Hernandez-Reif M. Preterm infant weight gain is increased by massage therapy and exercise via different underlying mechanisms. Early Hum Dev. 2014 Mar;90(3):137–40.
20. Mullany LC, Darmstadt GL, Khatry SK, Tielsch JM. Traditional Massage of Newborns in Nepal: Implications for Trials of Improved Practice. J Trop Pediatr. 2005 Apr;51(2):82–6.