Olive oil and hydration based on clinical assessment and transepidermal water loss: A systematic review

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Systematic Review

Olive oil and hydration based on clinical assessment and transepidermal water loss: A systematic review

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Abstract

Background: Dry skin or xerosis is a layer of skin that loses moisture due to increased transepidermal water loss (TEWL). Olive oil, one of the most commonly available moisturizers, is often used to keep the skin hydrated. Skin hydration indicates the amount of water in the stratum corneum. This systematic review aimed to determine the association between olive oil application and skin hydration based on clinical assessment and TEWL parameters.

Methods: The research design used was a systematic review based on the criteria of preferred reporting items for systematic reviews and meta-analyses (PRISMA). This systematic review search used PubMed, ProQuest, Google Scholar, CINAHL, and NLM Catalog databases. The risk of bias in the literature used in this study was assessed using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2).

Results: Five articles were included in this systematic review in which topical intervention on the skin was used with olive oil and other oils, placebo, or no therapy as controls. Olive oil can improve skin conditions clinically and provide various beneficial effects such as antioxidants and anti-inflammatory, but the oleic acid content, which is the main component of olive oil, has detrimental effects on the skin.

Conclusion: This systematic review reveals that olive oil can improve skin condition clinically, but long-term topical application of olive oil may damage the integrity of the skin and increase TEWL.

Keywords: olive oil, skin hydration, transepidermal water loss (TEWL)

Background

The skin is one of the largest single organs in the human body and is directly related to the external environment. Hence, the skin has a vital role in the outer protective function of the body from various external environmental influences (physical, mechanical, and chemical). Besides being protective, the skin regulates body fluid balance, sensory, temperature, metrics, and sexual signals.1 Maintaining skin health is a matter of great concern. Otherwise, the balance of fluids in the skin is disturbed, oil production in the skin is reduced, and harmful environments can cause dry skin.2 Dry skin or xerosis is a layer of skin that loses moisture levels. The loss of water from the surface layer of the skin due to increased transepidermal water loss (TEWL) causes the skin to become dry because a lot of water evaporates into the atmosphere. This loss of fluid can be caused by several conditions, such as windy weather, high and low environmental temperatures, dry air, use of materials containing surfactants, alkaline materials, organic solvents, proteolytic and lipolytic enzymes, aging processes, and various other skin disorders.2

Based on the Journal of the European Academy of Dermatology and Venereology, data on the prevalence of dry skin based on the age group of 48,630 people were analyzed; in the age range between 16 and 19 years, there were 16.7% who had dry skin, and prevalence of dry skin increases with age.3 Therefore, keeping skin healthy and...
improving dry skin is essential. The basic mechanism for restoring moisture to the skin can be done by increasing the binding and retention of water by applying a moisturizing agent. Plant oil, such as olive oil, is a moisturizer that can be used as a coating that can replace the natural hydrophilic layer, thereby reducing TEWL.

Research by Cui, et al. revealed that olive oil can significantly reduce the intensity of acute dermatitis, and its fatty acid components can act as a skin barrier that can coat and protect the skin. However, Other studies on the topical application of olive oil by Danby et al. stated that there was a decrease in the integrity and thickness of the stratum corneum, which could lead to an increase in TEWL in the olive oil intervention group. There are differences of opinion from several studies regarding the effect of olive oil on skin hydration, and many people still apply olive oil to the skin without knowing what effects it can have on its use. Therefore, this systematic study was made to identify, evaluate, and summarize the effects of olive oil on skin hydration.

Methods

The research design used was a systematic review based on the criteria of preferred reporting items for systematic reviews and meta-analyses (PRISMA) to see the relationship between olive oil and skin hydration. A systematic review is a type of research that uses systematic methods to collect secondary data, critically assess research studies, and analyze findings qualitatively or quantitatively.

This systematic review search uses the PubMed, ProQuest, Google Scholar, CINAHL, and NLM Catalog databases. The keywords used are listed in Table 1. The strategic search was designed to identify all relevant English language studies through September 2020. All of the studies examined up to September 2020 were related to the effectiveness of olive oil on skin hydration. Criteria for the object of study based on PICO (population, intervention, comparator, outcome) are described in Table 2. The literature included in this systematic review was a topical study of olive oil and skin hydration with human subjects, using a randomized-controlled trials (RCT) research method and English Language. Studies with only abstract or title being published and studies that did not have sufficient data were excluded from this systematic review.

The first thing to do was search for the literature using keywords that match the topic in the database used. The amount of literature obtained was rapidly screened to see if there were duplicates of literature among the databases used. The duplicates were then excluded. Titles and abstracts from the literature were collected and screened individually by the researcher to review the eligibility of the literature. The relevant full-text studies were assessed for suitability based on the population studied, the intervention given, the number of samples, the study duration, the measurement results, the inclusion and exclusion criteria, and the study results.

Three investigators assess the risk of bias in each literature using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2). The risk assessment of bias was reviewed from five domains, including the randomization process, intervention, assessment results, measurement tools, and reported results.

Table 1. Keywords

<table>
<thead>
<tr>
<th>No</th>
<th>Databases</th>
<th>Keywords</th>
<th>Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PubMed</td>
<td>&quot;Topical Olive Oil&quot; AND &quot;Transepidermal Water Loss&quot; OR &quot;TEWL&quot; OR &quot;skin hydration&quot; OR &quot;skin barrier&quot; OR &quot;dry skin&quot; OR &quot;xerosis&quot; OR &quot;skin dehydration&quot;</td>
<td>520</td>
</tr>
<tr>
<td>2.</td>
<td>ProQuest</td>
<td>&quot;Topical Olive Oil&quot; AND &quot;Transepidermal Water Loss&quot; OR &quot;TEWL&quot; OR &quot;skin hydration&quot; OR &quot;skin barrier&quot; OR &quot;dry skin&quot; OR &quot;xerosis&quot; OR &quot;skin dehydration&quot;</td>
<td>156</td>
</tr>
<tr>
<td>3.</td>
<td>Google Scholar</td>
<td>&quot;Topical Olive Oil&quot; AND &quot;Transepidermal Water Loss&quot; OR &quot;TEWL&quot; OR &quot;skin hydration&quot; OR &quot;skin barrier&quot; OR &quot;dry skin&quot; OR &quot;xerosis&quot; OR &quot;skin dehydration&quot;</td>
<td>64</td>
</tr>
<tr>
<td>4.</td>
<td>CINAHL</td>
<td>&quot;Topical Olive Oil&quot; AND &quot;Transepidermal Water Loss&quot; OR &quot;TEWL&quot; OR &quot;skin hydration&quot; OR &quot;skin barrier&quot; OR &quot;dry skin&quot; OR &quot;xerosis&quot; OR &quot;skin dehydration&quot;</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>NLM Catalog</td>
<td>&quot;Topical Olive Oil&quot; AND &quot;Transepidermal Water Loss&quot; OR &quot;TEWL&quot; OR &quot;skin hydration&quot; OR &quot;skin barrier&quot; OR &quot;dry skin&quot; OR &quot;xerosis&quot; OR &quot;skin dehydration&quot;</td>
<td>54</td>
</tr>
</tbody>
</table>
**Table 2. PICO Questions**

<table>
<thead>
<tr>
<th>Population</th>
<th>General population and patients with dry skin problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Topical olive oil</td>
</tr>
<tr>
<td>Comparator</td>
<td>Other moisturizers, placebo, or without treatment</td>
</tr>
<tr>
<td>Outcome</td>
<td>Clinical assessment and/or measurement with a measuring instrument</td>
</tr>
</tbody>
</table>

**Table 3. Overall Risk-of-Bias Judgement**

<table>
<thead>
<tr>
<th>Overall Risk-of-Bias Judgement</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk of bias</td>
<td>The study is judged to be at low risk of bias for all domains for this result.</td>
</tr>
<tr>
<td>Some concerns</td>
<td>The study is judged to raise some concerns in at least one domain for this result but not to be at high risk for any domain.</td>
</tr>
<tr>
<td>High risk of bias</td>
<td>The study is judged to be at high risk of bias in at least one domain for this result. Or The study is judged to have some concerns for multiple domains in a way that substantially lowers confidence in the result.</td>
</tr>
</tbody>
</table>

Each domain consists of several questions that must be answered with yes, possibly yes, no, possibly not, or no information. All questions answered referred to the final risk assessment of bias. The overall risk assessment of bias is based on the criteria in Table 3.

**Results**

Search results using keywords that have been determined in each database used are described in Figure 1.

The population in the study by Danby, et al. and Verallo-Rowel, et al. were adult patients aged ≥ 18 years with or without a history of atopic dermatitis. A study by Cooke, et al. took samples from infants with or without a family history of atopic eczema. The study by Al-Abdullah, et al. used a sample of neonates in the Neonatal Intensive Care Unit (NICU). Patients with an age range of 40-60 years old who received chemoradiotherapy were sampled in the study by Cui, et al.

The study design of the five studies included in the systematic review was randomized controlled trials (RCTs). All studies select samples and randomize samples. One study by Verallo-Rowel et al. used the double-blind method. Three studies by Danby, et al., Cooke, et al., and Cui, et al. used the single-blind method, whereas one study by Al-Abdullah, et al. did not mention the blinding method.

All studies in the five studies included in this systematic review had the same intervention, topical intervention of olive oil on the skin, but differed in control use, study duration, and amount of material applied. All studies described the active ingredients contained, but this systematic review focused on the effect of olive oil on skin hydration based on clinical assessment and TEWL parameters (Table 4).

Studies by Danby, et al. and Cooke, et al. used a pH meter to measure the pH of the skin surface, a corneometer to measure the hydration of the stratum corneum, a mexameter to measure the incidence of erythema in the skin, the AquaFlux AF200 to measure changes in TEWL, and infrared densitometry to measure the amount of protein in the skin, and ATR-FTIR spectroscopy to see changes in the structure of the lamella lipid.
The assessment of skin quality using a scoring system was carried out in four studies using the standardized scoring system, including scoring atopic dermatitis (SCORAD), skin condition grading scale, radiation skin reaction scoring, and neonatal skin condition score (NSCS). Laboratory examinations such as skin swabs were performed in the study by Al-Abdullah, et al. and Verallo-Rowel, et al. to assess skin colonization. The results of the bias risk assessment of the five studies using the revised cochrane risk-of-bias tool for randomized trials (RoB 2) are low risk of bias assessed based on existing algorithms. The five studies selected in this systematic review have minimal risk of bias in each of the domain (Table 5).
### Table 4. Characteristics of the Studies

<table>
<thead>
<tr>
<th>No</th>
<th>Studies</th>
<th>Populations</th>
<th>Samples</th>
<th>Intervention</th>
<th>Study Durations</th>
<th>Measurements</th>
<th>Study Results</th>
</tr>
</thead>
</table>
| 1. | Danby, et al., 2012, United Kingdom. | Adults Male/Female ≥ 18 years old | 19 | Intervention on forearm 3 cm below the elbow and 3 cm above the wrist  
  Group 1: Six drops (~31 microliter/drop) olive oil 2x/day for 5 weeks  
  Group 2: Six drops olive oil on one arm and six drops sunflower seed oil on another arm 2x/day for four weeks  
  Control: (without treatment) | Five weeks | AquaFlux AF200 | Topical olive oil increase transepidermal water loss (TEWL) in subjects with (p=0.001) or without (p=0.005) atopic dermatitis |
| 2. | Cooke, et al., 2016, United Kingdom. | Babies Male/Female 72 hours old | 115 | Four drops olive oil, sunflower oil on the left arm, left thigh, and stomach  
  Control: (without treatment) | Four weeks | AquaFlux AF200, neonatal skin condition score (NSCS) | There was no significant difference in TEWL between olive oil, sunflower oil, and control (p=0.05). Skin condition improved in general, but no significant difference was found between the three interventions (p=0.05) |
| 3. | Cui, et al., 2015, Shandong. | Patients that receive chemoradiotherapy aged between 40-60 years old | 94 | Application olive oil 3x/day for the first day of radiation therapy and continued for two weeks after radiation therapy, placebo (water) | Two weeks | radiation skin reaction scoring | Olive oil may reduce acute dermatitis significantly (p<0.01) |
| 4. | Al-Abdullah, et al., 2012, Saudi Arabia. | Preterm neonates Male/Female | 51 | Application olive oil (> 1 kg: 1.5 mL, < 1 kg: 0.75 mL) 2x/day on the surface of the body  
  Control: (without treatment) | Two weeks | skin condition grading scale | Olive oil may improve skin condition significantly (p value not mentioned) |
| 5. | Verallo-Rowel, et al., 2008, Philippines. | Adults Male/Female 18-40 years old | 52 | Application of 5 mL olive oil and virgin coconut oil 3x/day and massage gently for a few seconds at the affected area  
  Control: No treatment | Four weeks | scoring atopic dermatitis (SCORAD) | Both oils decrease the SCORAD score, but more significant in the virgin coconut oil group (p=0.004) |
This systematic study was conducted to determine the association between olive oil and skin hydration based on clinical assessment and TEWL parameters. Based on the results of the risk assessment of bias with RoB 2, the five studies included in this systematic review have good quality. All studies are classified as low-risk bias.

The study population included in this systematic review varied, especially regarding age and skin condition. Two studies sampled adult patients over 18 years of age with or without a history of atopic dermatitis. The increase in the incidence of skin problems increases with increasing age. One of the two studies did not mention a method of randomizing the population for sampling.

Dry skin is a common condition that results in skin roughness, tightness, flaking, and scaling. Dry skin can occur at any age, and it is not uncommon for babies to have dry, scaly skin on their lower legs. Dry skin is sensitive, easily irritated by external stimuli, and itchy. It can cause pruritus, leading to excoriations and an increased risk of skin infections. Xerosis is multifactorial in etiology and may occur in response to environmental changes, underlying diseases, medications, or advanced age. Xerosis is due to the loss of lipids in the skin, and most people worldwide will experience it at some stage in their lives.

The focus of the treatment in overcoming dry skin is restoring physiologic lipids in the epidermis, enhancing skin moisturization, optimizing skin barrier function, and promoting epidermal differentiation. Moisturizers are the oily ingredients that are most often used in dermatology. Moisturizers are used to increase the amount of water in the skin. It can improve skin hydration. The role of occlusion in moisturizers can inhibit TEWL. Apart from that, moisturizers also act as anti-inflammatory, antimitotic, antipruritic, photoprotective, antimicrobial, wound healing, and can improve quality of life. There are four main types of moisturizers, namely occlusives, humectants, emollients, and protein rejuvenators.

Plant oils have been found to have many positive physiological benefits. They have been used on the skin for cosmetics and medical. Olive oil is widely used among people worldwide for skin health. Olive oil comes from the fruits of Olea europaea trees. It consists mainly of oleic acid, with smaller quantities of other fatty acids such as linoleic and palmitic acids. The other minor components include α-tocopherol and phenol compounds. Olive oil has beneficial features such as anti-inflammatory, antioxidant, and antimicrobial properties.

Dry skin is common in neonates due to adaptation to the extrauterine environment faced by newborns. The study by Cooke et al. took samples from a population of infants aged 72 hours with or without a family history of atopic eczema. According to several studies, applying topical products to the dry skin of neonates can harm the skin barrier function and trigger the development of atopic eczema. Also, other studies use samples of neonates in the Neonatal Intensive Care Unit (NICU). The sample used in this study was preterm neonates (gestational age ≤ 34 weeks) because preterm neonates have less developed organs, one of which is the development of skin barrier function leading to increased risk of dehydration and thermal instability.

The study by Cui et al. recruited nasopharyngeal carcinoma patients who received chemoradiotherapy with an age of about 40-60 years as samples because the side effect that most often occurs in chemoradiotherapy is radiodermatitis.

Table 5. Results of Risk Bias Assessment

<table>
<thead>
<tr>
<th>No.</th>
<th>Studies</th>
<th>Domain</th>
<th>Overall Risk-of-Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Danby, et al., 2013.</td>
<td>Low risk</td>
<td>Low risk</td>
</tr>
<tr>
<td>2.</td>
<td>Cooke, et al., 2016.</td>
<td>Low risk</td>
<td>Low risk</td>
</tr>
<tr>
<td>3.</td>
<td>Cui, et al., 2015.</td>
<td>Low risk</td>
<td>Low risk</td>
</tr>
<tr>
<td>4.</td>
<td>Al-Abdullah, et al., 2012.</td>
<td>Low risk</td>
<td>Low risk</td>
</tr>
<tr>
<td>5.</td>
<td>Verallo-Rowel, et al., 2008.</td>
<td>Low risk</td>
<td>Low risk</td>
</tr>
</tbody>
</table>
The study designs included in this systematic review are randomized controlled trials (RCTs). This method is the most reliable for assessing therapeutic interventions' effects.\textsuperscript{18} One study used the double-blind method, and three used the single-blind method, which is an observer or assessor-blinded.\textsuperscript{3,5,7,8} One study by Al-Abdullah, et al. did not mention the blinding method used in the study.\textsuperscript{9} Blinding is an important component in RCT because it is expected to reduce the study's bias level.\textsuperscript{18}

The studies included in this systematic review used various measuring tools to assess skin conditions in various aspects. Measurements are performed using measuring instruments, scoring systems, or laboratory examinations. However, this systematic review only focuses on clinical assessment and TEWL measurements. All studies in this systematic review took measurements before intervention as the baseline and after intervention. The intervention conducted in the five studies topically applied the ingredients to the skin of the participants, either to certain parts of the body, one side of the extremities, or the whole body. Most of these studies intervened twice a day for 2 to 5 weeks.\textsuperscript{4,5,7-9}

Vegetable oils such as olive oil can have an occlusive effect on the skin, reduce TEWL from the stratum corneum and regulate keratinocyte proliferation.\textsuperscript{19} The ingredients contained in olive oil also have beneficial effects on the skin, such as squalene, tocopherol, and resveratrol, which function as antioxidant agents, slowing down the aging process of the skin, and the small amount of linolenic acid in olive oil can act as an anti-inflammatory.\textsuperscript{15} Cold-pressed or crude oil is recommended because it does not undergo heating or other chemicals that can change its composition and act as a skincare ingredient because it is less irritating, increases skin hydration, and improves skin barrier function. However, for example, extra virgin olive oil can disrupt the pH of the stratum corneum and enzymatic activity in the formation of the skin barrier, impairing its function. The more oleic acid is contained in the oil, the more harmful the oil is to the skin.\textsuperscript{19,20} Free fatty acids, specifically monounsaturated free fatty acids such as oleic acid, may disrupt the skin barrier and act as permeability enhancers for other compounds in plant oils.\textsuperscript{21}

Clinical practice by de Meza T. stated that refined oil is better because it has a lighter consistency, no odor, a longer shelf life, and is less allergic. Refined oil contains very low oleic acid, which has antibacterial, moisturizing, and regenerating effects on the skin barrier.\textsuperscript{22} Oil refining process destroys proteins, causing allergies and reducing the risk of allergic reactions. In contrast, crude oil is declared unsterile and contains many bacteria and fungi spores that can grow when skin moisturizes.\textsuperscript{8,22}

The results of the study by Al-Abdullah, et al. stated that there was a significant improvement in skin condition and body temperature regulation in preterm neonates after two weeks of topical olive oil intervention. However, its use could increase the occurrence of bacterial colonization of the skin. Body temperature regulation is associated with decreased TEWL and may exert beneficial effects on neonates.\textsuperscript{9} Topical application of olive oil was also effective in preventing acute skin lesions in patients with nasopharyngeal carcinoma receiving chemoradiotherapy. A study by Cui, et al. suggested that olive oil's antioxidant and anti-inflammatory effects play an essential role in reducing the intensity of radiodermatitis. Besides that, the linoleic acid content in olive oil also affects skin physiology, skin barrier function, membrane fluidity, and eicosanoid production.\textsuperscript{4} Verallo-Rowell, et al. conducted a study comparing the emollient effects of virgin coconut oil and olive oil in atopic dermatitis patients. The two types of oil lowered the SCORAD index but more significantly in the intervention group with virgin coconut oil. This difference is due to the difference in the size of the fatty acid monoglycerides in the two oils. Olive oil is said to be a weak irritant to topical application. These side effects, like reduction in the integrity and thickness of the stratum corneum, increase TEWL, which then induces cutaneous irritation and inflammation/acts as a modest vasodilator, causing the incidence of mild erythema in respondents with/without a history of atopic dermatitis are rare.\textsuperscript{7}

Another statement regarding topical oils is that they can hydrate the stratum corneum and, at the same time, interfere with the lamellar structure of lipids in the skin due to triglyceride lipolysis and release of glycerol, linoleic acid, and oleic acid. Glycerol contained in olive oil plays an essential role as a moisturizing factor in the stratum corneum and improves skin hydration. In contrast, oleic acid, the main component of olive oil, increases TEWL. The results of lipid lamellar structure measurements in the study of Cooke, et al. mentioned that topical oils can harm a baby’s skin. Generally, babies have increased lipid formation on both the skin surface and the stratum corneum layer within four weeks of life, but in the group of infants who were given intervention with topical oils, there was a
disturbance in the lamellar lipid structure, which decreased the function of the skin barrier, increased the permeability of the stratum corneum, and could increase the risk the occurrence of atopic eczema. A review of the study also suggested that olive oil inhibits development and has a detrimental effect on the skin barrier. Olive oil is not recommended for use on infant skin by the International Association of Infant Massage.

Similar to the study by Danby, et al. applying olive oil twice daily for four weeks reduced the integrity and thickness of the stratum corneum, thereby significantly increasing TEWL. Poor skin barrier function induces cutaneous irritation, erythema, and inflammation in samples with or without a history of atopic dermatitis. The oleic acid in olive oil accelerates the penetration effect by inducing the separation of lipids in the skin, which can cause an increase in TEWL.

Oils containing large amounts of oleic acid, such as olive oil, even in small amounts, can be an irritant agent, damage skin integrity, disrupt the lipid barrier in the stratum corneum, increase skin permeability, and induce the breakdown of the skin barrier structure when used as a moisturizer. An in-vivo study stated that the higher the oleic acid content, the higher the TEWL, which indicates damage to the skin barrier and facilitated water transfer by oleic acid.

The results of a systematic review of the five studies above show that although olive oil can improve skin conditions clinically and provide various beneficial effects for the skin, such as antioxidants and anti-inflammatory, the content of oleic acid, which is the main component of olive oil, has a detrimental effect on the skin, which can damage the integrity of the skin and increase TEWL significantly if applied long term. Based on in-vivo research, oleic acid causes a significant increase in TEWL and skin irritation. Research by Viljoen, et al. suggested that oils composed mostly of monounsaturated oleic acid disrupt the skin barrier by increasing skin permeability more than oils containing an almost even mixture of monounsaturated and polyunsaturated fatty acids.

Oleic acid may also induce inflammation through a molecule inhibitor of α-methyl-d-aspartic acid (NMDA)-type in keratinocytes that have been shown to reduce TEWL caused by the application of oleic acid on the skin of mice. An ideal moisturizer, according to an article in the Indian Journal of Dermatology, is a moisturizer that should reduce and prevent TEWL, improve lipid barrier, be hypoallergenic, do not make sensitive skin, without fragrances, non-comedogenic, absorbent, and provide hydration to the skin, are cosmetically acceptable, and reachable.

This systematic review has strengths: It is the first systematic review to discuss the relationship between olive oil and skin hydration based on clinical assessment and TEWL parameters. The studies included in this systematic review have a low risk of bias, as evidenced by the results of the RoB 2 assessment. Regardless of its strength, this qualitative study also has several limitations: research limited to humans, topical intervention, and English language.

**Conclusion**

This systematic review concludes that topical application of olive oil can improve skin conditions clinically, but long-term use can have detrimental effects on the skin. The main fatty acid content in olive oil, namely oleic acid, can induce irritation, disrupt skin integrity, disrupt the lipid barrier in the stratum corneum, increase skin permeability, and induce the breakdown of skin barrier structures to increase TEWL.

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**Author’s Contribution**

All the authors conceived the review and approved the final manuscript.

**Conflicts of Interest**

No conflict of interest.

**References**


