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A Public Awareness Model For The Dietary Management Of Dry Eye Syndrome

[1]Dr. Deepshikha, [2]Dr. Ayub Ali,
[1]Department of Clinical Nutrition, Santosh Deemed to be University, Ghaziabad, Uttar Pradesh, India
[2]Department of Optometry, Santosh Deemed to be University, Ghaziabad, Uttar Pradesh, India

Abstract

Background:
Dry Eye Syndrome (DES) is a multifactorial ocular condition affecting tear film stability, ocular surface integrity, and visual comfort. In India, urban lifestyles, dietary deficiencies, and limited public awareness contribute to the growing burden of DES. Nutritional modulation, particularly the consumption of omega-3 fatty acids, antioxidants, and hydration-promoting foods, plays a crucial role in the management and prevention of this condition. Despite the available evidence, awareness of dietary interventions among patients remains low.

Objective:
To develop, implement, and evaluate a Public Awareness Model for the Dietary Management of Dry Eye Syndrome (PAMD-DES) aimed at improving knowledge, dietary adherence, and ocular surface health among adults in Delhi-NCR, India.

Design:
A 12-month quasi-experimental interventional study with pre- and post-assessment.

Participants / Materials:
A total of 420 adult participants (aged 25–60 years) diagnosed with mild-to-moderate DES based on Ocular Surface Disease Index (OSDI) scores and Tear Break-Up Time (TBUT) were recruited from Asim Eye Care Clinic, Delhi-NCR.

Intervention:
Participants were randomized into two groups:

- **Group A (Intervention group, n = 210)**: Received structured dietary education sessions, printed infographics, and weekly digital reminders emphasizing omega-3, vitamin A, C, E, and hydration-rich dietary practices.
- **Group B (Control group, n = 210)**: Received standard ophthalmic care without dietary education.

Outcomes:
Changes in (1) dietary awareness scores, (2) omega-3 intake levels, (3) OSDI scores, (4) TBUT, and (5) Schirmer's test values were assessed at baseline, 6 months, and 12 months.

Results:
Post-intervention, Group A showed a significant improvement in awareness score (from 42.5 ± 11.2 to 83.4 ± 9.6, $p < 0.001$), mean OSDI reduction (from 38.6 ± 7.3 to 19.1 ± 6.4, $p < 0.001$), and mean TBUT increase (from 5.8 ± 1.4 s to 10.7 ± 1.9 s, $p < 0.001$). Omega-3 intake rose by 64%, while Schirmer's scores improved by 45%. The control group exhibited no statistically significant change ($p > 0.05$).

Conclusions:
The PAMD-DES successfully enhanced dietary literacy and ocular surface health in DES patients. Public health campaigns integrating nutritional education with ophthalmic care may serve as sustainable community-based strategies for DES prevention and management.

Keywords - Dry Eye Syndrome, Public Awareness, Dietary Management, Omega-3 Fatty Acids, Nutritional Education, Ocular Health, Community Intervention, India

1. INTRODUCTION

Dry Eye Syndrome (DES), also referred to as keratoconjunctivitis sicca, is one of the most prevalent ocular surface disorders, characterized by a loss of homeostasis of the tear film and accompanied by ocular symptoms such as irritation, redness, blurred vision, and photophobia. According to the TFOS DEWS II Report (2017), DES is a multifactorial disease involving tear film instability, hyperosmolarity, inflammation, and neurosensory abnormalities. Globally, DES affects approximately 344 million people, with prevalence estimates ranging from 5% to 50% depending on population demographics, diagnostic criteria, and environmental exposure.

In India, the prevalence of DES has increased rapidly, particularly in metropolitan cities such as Delhi – NCR, where pollution level is very high. A large-scale epidemiological study by Gupta et al. (2022) reported that 32% of adults in urban India exhibit moderate-to-severe dry eye symptoms, largely attributed to increased digital screen exposure, air-conditioned environments, and nutritional imbalances. The expanding urban population and evolving dietary patterns—marked by the replacement of traditional omega-3–rich foods (such as mustard oil and freshwater fish) with processed oils and fast food—have created a silent but significant public health challenge.

Emerging evidence suggests that diet plays an integral role in ocular surface integrity. Omega-3 fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are known to improve meibomian gland function and reduce inflammatory cytokines (IL-1β, TNF-α) associated with tear film instability. Deficiency of vitamin A, vitamin C, vitamin E, and carotenoids impairs epithelial differentiation, tear secretion, and antioxidant protection. Similarly, inadequate hydration and excessive caffeine or alcohol consumption can exacerbate tear osmolarity and ocular discomfort.

Despite the strong evidence linking nutrition to ocular health, awareness about dietary prevention and management of DES remains alarmingly low in India. A 2021 survey by the All-India Ophthalmological Society (AIOS) revealed that less than 18% of dry eye patients had received dietary guidance from healthcare professionals. Moreover, only 12% were aware of omega-3 supplementation benefits, while 65% believed DES was exclusively caused by digital screen exposure.

Public health education focusing on dietary literacy for eye health has not been prioritized in national campaigns. This study, therefore, addresses this gap through the Public Awareness Model for Dietary Management of Dry Eye Syndrome (PAMD-DES)—a structured, community-based framework integrating nutrition education, behavioural reinforcement, and clinical monitoring. This model hypothesizes that improving public understanding of nutritional factors associated with DES can significantly enhance both self-management behaviour and clinical outcomes.

2. METHODOLOGY

2.1 Study Setting and Duration

The study was conducted between January 2024 and December 2024 at Asim Eye Care Clinic, Delhi-NCR, a tertiary-level ophthalmic and nutrition-integrated care centre. The climate and urban environmental exposure of Delhi make it an ideal setting for studying DES, given its high particulate pollution index (AQI > 150 for over 200 days/year).

2.2 Sample Selection

A total of 420 participants were enrolled following a screening of 615 individuals. Participants were stratified by gender and occupation (IT professionals, homemakers, and administrative staff). Recruitment employed simple random sampling among eligible outpatients with clinically diagnosed mild-to-moderate DES.

2.3 Study Design

A quasi-experimental, pretest–posttest control group design was utilized. Participants were randomly assigned to:

- **Group A (n=210):** Intervention group receiving dietary education plus standard care.
- **Group B (n=210):** Control group receiving standard ophthalmic care only.

2.4 Intervention Details

The Public Awareness Model for Dietary Management (PAMD-DES) comprised three interconnected modules:

Module 1 – Nutritional Awareness

- Four in-person group workshops conducted by clinical nutritionists and ophthalmologists.
- Visual aids, leaflets, and infographics in English and Hindi.
- Educational content on omega-3 sources (flaxseed, fish oil, walnuts), antioxidant-rich foods, and hydration strategies.

Module 2 – Digital Reinforcement

- Weekly WhatsApp infographics and short diet plans and Eyes exercises tips.
- Monthly WhatsApp reminders on water intake and balanced meals.
- Peer-support chat groups for sharing meal photos and progress updates.

Module 3 – Clinical and Behavioural Monitoring

- Monthly follow-up visits for OSDI assessment and tear film testing.
- 3-day dietary recalls evaluated using Indian Food Composition Tables (IFCT 2021).
- Adherence scored using a Nutritional Compliance Index (0–100).

2.5 Outcome Measures

1. **Primary Outcomes:**

- Change in OSDI score (0–100 scale).
- Change in Dry Eye Awareness Score (DEAQ).

2. **Secondary Outcomes:**

- TBUT (seconds), Schirmer's test (mm/5 min).
- Omega-3 intake (g/day).
- Compliance index.

2.6 Data Analysis

Data were analysed using SPSS v27.0. Continuous variables were expressed as mean ± SD.

- Paired t-tests compared within-group differences.
- Independent t-tests and ANOVA compared between-group changes.
- Pearson's correlation evaluated associations between awareness and clinical parameters. A p-value < 0.05 denoted statistical significance.

2.7 Ethical Considerations

Informed consent was obtained from all participants.

3. RESULTS

3.1 Baseline Demographics

Parameter	Group A (n=210)	Group B (n=210)	p-value
Mean Age (years)	39.7 ± 8.2	40.3 ± 7.9	0.56
Gender (M/F)	80/130	85/125	0.71
Screen Time (hours/day)	6.8 ± 1.5	6.6 ± 1.6	0.34
Baseline OSDI	38.6 ± 7.3	37.9 ± 7.5	0.44

3.2 Awareness and Dietary Intake

At baseline, both groups scored low in awareness (mean = 42.5 ± 11.2). After 12 months:

- Group A improved to 83.4 ± 9.6 ($p < 0.001$).
- Group B remained nearly unchanged (44.7 ± 10.9, $p = 0.08$).

Omega-3 intake (g/day):

- Group A: 0.65 → 1.07 ($p < 0.001$).
- Group B: 0.63 → 0.66 ($p = 0.12$).

3.3 Clinical Outcomes

Outcome	Group A Baseline	Group A Post	Group B Baseline	Group B Post	p-value (A vs B)
OSDI	38.6 ± 7.3	**19.1 ± 6.4**	37.9 ± 7.5	36.8 ± 7.0	<0.001
TBUT (s)	5.8 ± 1.4	**10.7 ± 1.9**	5.9 ± 1.5	6.1 ± 1.6	<0.001
Schirmer's (mm)	8.6 ± 3.0	**12.5 ± 3.2**	8.8 ± 2.8	9.0 ± 3.0	<0.001

3.4 Correlation Analysis

A strong positive correlation was found between omega-3 intake and TBUT (r = 0.68, $p < 0.01$). Increased awareness score correlated negatively with OSDI ($r = -0.74$, $p < 0.001$), confirming behavioural impact.

4. DISCUSSION

The findings of this study underscore the transformative potential of structured public awareness initiatives in chronic ocular disease management. The PAMD-DES model demonstrated significant improvements in dietary literacy, nutrient intake, and ocular surface health, establishing a direct link between education-driven behaviour change and measurable physiological outcomes.

4.1 Nutritional Behaviour and Clinical Improvement

Participants who attended the workshops showed a 64% rise in omega-3 intake and 45% improvement in Schirmer's values—reflecting enhanced meibomian gland secretion and lipid layer stabilization. The strong correlation (r = 0.68, $p < 0.01$) between omega-3 intake and TBUT reinforces prior mechanistic findings by Kawashima et al. (2018) that omega-3 modulates meibum composition, reducing tear evaporation.

4.2 Mechanisms Underlying Improvement

The dietary pattern adopted post-intervention resembled a Mediterranean-inspired Indian diet, rich in leafy greens, citrus fruits, and cold-pressed oils. This nutritional shift likely improved systemic anti-inflammatory status, enhancing lacrimal gland performance. Elevated intake of vitamin C and E may have reduced oxidative damage at the corneal surface, consistent with Galor et al. (2020).

4.3 The Role of Awareness and Adherence

The observed increase in awareness score (42.5 → 83.4) mirrors models of health literacy where knowledge directly predicts compliance. Behavioural reinforcement through digital engagement sustained adherence—highlighting that tech-enabled health education can amplify traditional interventions in resource-limited contexts.

4.4 Comparative Analysis

When benchmarked against international interventions, our model achieved similar or superior outcomes. The Japanese Eye Health Literacy Trial (2019) improved OSDI by 32%, while PAMD-DES achieved a 50% reduction within one year—suggesting that culturally contextualized programs may yield higher efficacy in Indian populations.

4.5 Implications for Integrative Healthcare

This study contributes evidence supporting the inclusion of clinical nutrition counselling within ophthalmology practice. Integrative models are likely to reduce recurrence rates of DES, lower dependency on lubricating drops, and improve patient quality of life.

5. COMPARISON WITH PRIOR STUDIES

Earlier studies (Miljanović et al., 2005; Kawashima et al., 2018) identified omega-3 deficiency as a modifiable risk factor for DES. However, few Indian studies integrated public education and nutrition literacy into DES management.

Our intervention extends beyond clinical supplementation trials (Bhargava et al., 2019; Galor et al., 2020) by embedding nutrition into a community engagement model. Similar to the "Eye Health Literacy" project in Japan, the PAMD-DES combined visual learning, mobile reminders, and dietary monitoring, yielding comparable improvements in awareness (>70%).

6. STRENGTHS

- Large sample size with equal gender representation.
- Longitudinal follow-up with objective ocular tests.
- Use of culturally tailored dietary materials in Hindi and English.
- Integration of digital reinforcement (WhatsApp, SMS).

7. LIMITATIONS

- Single-centre study limits generalizability.
- Dietary intake based on self-reported recall may include bias.
- No biomarker confirmation (plasma omega-3 or inflammatory cytokines).
- Limited follow-up beyond 12 months.

8. PUBLIC HEALTH IMPLICATIONS

The success of PAMD-DES underscores the necessity of multidisciplinary collaboration—linking ophthalmologists, nutritionists, and community educators. Given the rising digital device usage and urban dietary shifts, such public health interventions can reduce the future burden of chronic ocular disorders.

Government eye health initiatives could adopt similar models, incorporating nutritional modules into National Programme for Control of Blindness (NPCB) campaigns.

9. CONCLUSIONS

The Public Awareness Model for Dietary Management of Dry Eye Syndrome significantly improved awareness, nutrient intake, and clinical outcomes among adults in Delhi-NCR. Dietary education must be recognized as an integral adjunct to ophthalmic care. The evidence supports nationwide replication through community-based platforms to curb DES progression.

10. PRACTICAL RECOMMENDATIONS

1. **Integration into Eye Camps:** Include brief nutritional talks during public eye check-ups.
2. **Mobile Education:** Develop multilingual eye health apps promoting omega-3–rich diets.
3. **School & Workplace Programs:** Implement "Eye Nutrition Weeks" to promote hydration and digital hygiene.
4. **Policy Inclusion:** Recommend dietary counselling in DES treatment protocols.

11. FUTURE DIRECTIONS

- Multi-centre replication across India to validate scalability.
- Incorporation of biochemical markers (e.g., omega-3 index, cytokine profiles).
- Comparative evaluation with pharmacological interventions.
- Longitudinal follow-up beyond 2 years to assess sustainability.

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