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Scopus Review of the Incidence, Treatment and Control of the Spread of Trachoma Species in Nigeria in the Past 5 Decades

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Abstract

Trachoma is a neglected tropical disease of the eye which is caused by the bacteria, *Chlamydia trachomatis*, and if untreated can lead to blindness. It can be transmitted through contact with ocular or nasal discharge of an infected person. WHO, in 2014, reported that 29 out of the 46 countries of the African region, are thought to be endemic and they account for 77% of the total population estimated to be living in endemic areas globally. Estimation of more than 110 million people reside in confirmed endemic areas and another 210 million reside in suspected endemic areas in up to 59 countries, excluding Brazil and India as there is lack of evidence of the disease in these countries. The prevalence rate globally has greatly reduced from 1.5 billion in 2002 to under 137 million in May 2020. Population based survey in Nigeria in different years showed a great prevalence of trachoma (TF and TT) in the Northern part of the country, and also a significant decrease as a result of the implementation of the SAFE strategy.

Background: Trachoma is a neglected tropical ocular infection caused by the bacteria *Chlamydia trachomatis*, and if untreated can lead to blindness. It can be transmitted through contact with ocular or nasal discharge of an infected person. The SAFE strategy involving surgery, Antibiotics, facial cleanliness, and environmental improvement; has long been devised for the management and control of this disease. Trachoma has affected over 2.2 million people, of which estimated 1.2 million people are irreversibly blind. The prevalence rate globally has greatly reduced from 1.5 billion in 2002 to fewer than 137 million in May 2020. Population based survey in Nigeria in different years showed a great prevalence of trachoma (TF and TT) in the Northern part of the country.

Methods: The British and Nigerian journal of ophthalmology, PubMed, the Scientific World Journal, trachoma atlas, WHO website, Cureus website, C.D.C website, Sightsavers website, American Academy of Ophthalmology, Pediatrics Infections Disease Journal, Journal of Clinical Microbiology were searched for relevant studies published for the past five decades on Trachoma in Nigeria. Papers on its prevalence, clinical features, diagnosis, treatment, control measures and recent findings in Nigeria were included.

Results: Collation of findings data from the past five decades on trachomatis infection in Nigeria has shown that the rate of infection has significantly reduced in some Northern part of the country due to trichiasis associated surgeries and use of antibiotics for Follicular inflammation. TF (0.2% and 9%); TT (0.2% and 8.0%) in Zamfara. TF (1.7% to 15.8% in 1 to 9 years of age); Tt (0% to 2.1%) common among women in Nasarrawa and Plateau state. TF (17.5%); TT (10.9% above 15 years) in Kano. TF (5.0% and 9.9%); TT (surgical services needed to obtain prevalence of <1 per 1000 total population in Niger State. TF (18.3%) TT (3.8%) in Yobe. TF (0.0% to 0.5%) in 13 local governments in Taraba.

Conclusion: The results from this five decades wide review suggest that though a marked reduction in trachomatis infection in different parts of the country is observed, however there is still high prevalence (TF & TT) mostly in the Northern part of the country, which calls for adequate availability of resources for mapping project, which will serve as a guide for control; intense implementation of the SAFE strategy and every other hygienic mechanism possible, and orientation on this disease particularly in endemic communities in the North.

Keywords: Incidence, Treatment, Trachoma Species, Nigeria, Five Decade

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Introduction

The number of blind in the world is not accurately known, but it has been estimated at various times by the World Health Organization (WHO). Thus, in 1972, report showed that there might be 10 to 15 million blind globally [1].

Trachoma, one of the most common causes of infectious blindness is caused by the bacteria *Chlamydia trachomatis*, an intracellular obligate parasite [2]. Particular serovars of *Chlamydia trachomatis* causes trachoma, and these bacteria are spread by its direct contact with the eye and nose discharge from infected individuals. This contact can happen with fomites (inanimate objects that carry infectious agents, such as towels or washcloths), or by eye-seeking flies, mostly *M. sorbens* [3]. The serovars of C. trachomatis are indicated by A to K letters, plus Ba, Da, Ia, and Ja [4-6]. Serovars A to C (A, B, Ba, and C) are the usual ocular isolates from patients with clinical trachoma in regions where trachoma is endemic. Trachoma highly infects young children with poor facial hygiene, their mothers due to the fact they tend to have high contact hours with their offspring [7,8]. An infected patient first shows a sign of conjunctiva inflammation, which subsequently leads to scarring.

Repeated infection and of course scarring results to entropion – inturning of the eyelid. Trichiasis results in an intense painful rubbing of the lashes against the cornea, resulting to corneal scarring, and hence irreversible blindness. First incidence of trachoma infection doesn't result to blindness, but repeated episodes of reinfection and inflammation leads to blindness [9]. Geographically, trachoma is endemic and a greater public health risk in dry, dusty, and hot, poor and rural environmental settings, where children with unclean faces share infected ocular secretions. Trachoma has been reported to be endemic in approximately 53 countries based on the 2010 country reports [10]. Based on the progress report on elimination of trachoma, 2010, towards the Global WHO Alliance for the Elimination of trachoma by 2020, rated trachoma among the oldest known ocular disease, found in the eyelids of Egyptian mummies. French and British troops returning from the Napoleonic campaigns in Egypt brought the disease to the slums of Europe (where it was known as Egyptian ophthalmia). The disease spread drastically from Europe to the United States.

However, with increased advancement in hygienic methods, coupled with socio-economic development, trachoma has been eliminated from Europe and the United States. The International Coalition for Trachoma Control roadmap for the elimination of blinding trachoma, 2020 insight [10], provides an overview of current data based on the trachoma atlas [10], estimating that more than 110 million people reside in confirmed endemic areas and another 210 million reside in suspected endemic areas in up to 59 countries, excluding Brazil and India as there is lack of evidence of the disease in these countries.

With the increase in infection rate, the available data on disease epidemiology have also increased. Trachoma is generally endemic in undeveloped countries, although Australia has been recorded as the only developed country where trachoma is endemic in its Aboriginal population. According to WHO (2014) [10,11] and among the WHO regions, only the European region has no country in which blinding trachoma is known or suspected to be a public health problem [11].

However, the African region is the most severely affected [10,12], and also the region in which the greatest efforts to intervene are underway. Other endemic regions include the Middle East, Southwestern Asia, regions of India and China and small regions in South and Central America [1]. Mexico, Morocco, and Oman, are where the infection have successfully controlled [1,13]. In other regions, trachoma, after being knocked down recurs at a much lower prevalence.

WHO (2014) [10], reports that 29 out of the 46 countries of the African region, are thought to be endemic and they account for 77% of the total population estimated to be living in endemic areas globally. The African region, because of the severity of infection and the risk of blindness from trachoma, remains a priority for intervention. It is worthy to note that repeated infection by *C. trachomatis* can only occur when the bacteria are endemic. One attempt at modeling data found out that threshold for scarring of the conjunctiva was repeated infections, and at least 130 infections were required to produce trichiasis [14]. Approximately, 334,000 disability-adjusted life years are currently lost due to trachoma infection [15]. The global burden of trachoma instigated the founding of the Global Alliance for Elimination of Blinding Trachoma by 2020 [16] in 1997, which has led to a reduction in the global burden from 84 million cases of active trachoma in 2003 to 21.4 million in 2012 [8]. The goal of the GET 2020 [16]. Alliance is towards eliminating blinding trachoma and putting together resources, as well as global partnership of member states, non-governmental organizations, and the private sector [3]. The following year, a World Health Assembly (WHA) resolution called for trachoma elimination by 2020 using the SAFE strategy (a simple, low-cost "surgery" for patients with advanced stages of the disease, treatment with "antibiotics", azithromycin or tetracycline eye ointment, "facial cleanliness", and "environmental improvement" encompassing of increased water access), endorsed by the World Health organization (WHO) has been helpful in control of trachoma and has contributed to a considerable elimination of the disease. It was believed that the combined approach would rapidly eliminate prevalence of trachoma, of which in a few regions of the world, prevalence has greatly reduced [17].

After about two decades of global work, the number of people at risk of blindness from trachoma reduced from 1.5 billion in 2002 to under 137 million in May 2020 [17]. Also, in the same year the estimated number of people with Trachomatous Trichiasis (TT); by May 2020 dropped to 2 million. In 2020, WHO validated 13 countries (Cambodia, China, Ghana, Islamic Republic of Iran, Lao People's Democratic Republic, Mexico, Morocco, Nepal, Gambia, Iraq, Myanmar, Togo and Oman) as being trachoma free. Year 2020 [16] was set as target date for the elimination of trachoma as a public health problem. Although there has been considerable decrease in its prevalence globally, it still remains a major concern in over 40 countries, including Nigeria. The new target for global elimination of trachoma as a public health problem is 2030 [17]. Measures visualized in the new 2021-2030 NTD road map include shift from atomistic method of disease approach to a holistic approach based on universal health coverage [17]. As the journey for the elimination of trachoma continues, hence the need for an annual review to ensure the progress of its elimination.

Prevalence of Trachoma in Nigeria

Nigeria, the most populous nation in Africa lies between latitude 4°N and 14°N and longitude 2° and 15°E, with approximately 200 million people [18].

Globally, trachoma has been reported to be a burden, but the

case seemed to be different in Nigeria until 1999 when a population-based survey reported trachoma as a public health problem in Northern part of Nigeria [19,20]. Hospital based studies proved the authenticity of the reports [21], moreover, trachoma was later confirmed as a public health problem in Nigeria from Population-based surveys [22,23]. The prevalence of the disease is in the range 0.6% to 17.6% for Trichiasis and 5% to 49% for active trachoma across the trachoma belt of Nigeria [12]. Fight towards eradicating trachoma have caused several NGOs like Sight savers, the Carter Center, Helen Keller International (HKI), and Christoffel Blindenmission ((CBM); and local governments to form a trachoma control forum, sharing ideas and resources in the control of the disease. The trachoma belt of Nigeria is enormous. Out of the 774 districts in Nigeria, more than half of it is populated with over 80 million people, covering over 500,000 km^2. NGOs, as the main advocates of combating trachoma are unable to provide enough resources needed to conduct a district-by-district population survey [12]. Due to lack of this date, there has been a set-back in the control of trachoma. Previous trachoma surveys in some Local Government Areas (LGAs) of Zamfara [24], and neighboring states [22-26] have reported different pattern of the magnitude of the disease with Trachomatous inflammation – Follicular (TF) prevalence ranging between 0.2% and 49%; and TT (Trachomatous Trichiasis) prevalence ranging between 0.2% and 8.0% across the states. Following a district-based, household cluster surveys conducted in all 30 Local Government Areas (LGAs) within Nasarawa and Plateau states in Central Nigeria, Results showed that a total of 46,960 persons were examined from 7,883 selected households. Prevalence estimates of trachomatous inflammation follicular among children 1 to 9 years of age ranged from 1.7% to 15.8% by LGA. Trichiasis prevalence among adults varied by LGA from 0% to 2.1% and was more common among women (OR=1.99, 95% CI 1.3 to 3.1) Access to water within a 30 min round trip was reported by 82.3% of households [26].

A population-based survey was conducted in Kano State with a total of 4,491 people examined. One to 9 years were about 1,572, and in them were found the prevalence of Trachomatous inflammation – Follicular (TF) – 17.5%. The prevalence of trachomatous trichiasis in persons aged ≥ 15years was 10.9%. Trichiasis was more common in adult females than adult males [26].

Population based-survey carried out in 25 local government areas of Niger State showed that prevalence of trachoma is relatively low in most of the state. Only one L.G.A. (Rafi) had TF prevalence between 5.0 and 9.9%. Triachiasis surgical services is needed in six L.G. As to achieve a prevalence of <1 case of trichiasis per 1,000 total population [27]. The proportion of household with access to improved water sources ranged from 23 to 100%, while household level access to improved latrines [28] ranged from 8% to 100% across the L.G.As.

In Yobe State, North-Eastern Nigeria, out of the 3,335 people examined, 17.9% of blindness was due to trachomatous corneal opacity. The prevalence of TF in children less than 1 to 9 years was 18.3% while TT in adults above 15 years was 3.8%, with adult females likely to have trichiasis than males [29]. In Taraba State, high prevalence of trichiasis ranged from 0.0% to 0.8% [30]. The prevalence of TF in children aged 1 to 9 years in the 13 local governments ranged from 0.0% to 0.5%. These data and more show that Nigeria is at high risk of Trachoma disease, which demands the intense and vast implementation of all aspects of the trachoma control program recommended by the World Health Organization to eliminate this avoidable cause of blindness [29].

Clinical features of trachoma

In the early stages of trachoma, pink eye evolves. Early symptoms such as: mild itching and irritation of the eyes, and eyelids; a discharge from the eyes, begin to appear within five to twelve days of exposure to the bacterium [6]. However, some persons infected with trachoma may appear asymptomatic.

According to WHO initiated simplified system [31] for grading of trachoma disease, clinical manifestations are as follows (Figures 1-5):

Follicular Trachoma (TF) characterized by the presence of five or more follicles, each at least, 0.5 mm in diameter in the central part of the upper tarsal conjunctiva [6,32]. TF is prevalent in children from 3 to 5 years old, and it is believed that the presence of follicles is an indicator of active disease.

Trachomatous Inflammation Intense (TI) characterized by the inflammation and thickening of the upper tarsal conjunctiva causing obscurity in more than half of the normal deep tarsal vessels. Following development of TI, there is risk of increase in conjuctivial scarring.

Trachoma Scarring (TS) indicated by the presence of visible scars, white lines, and sheets of fibrosis in the tarsal conjunctiva. TS serves as an indicator of previous inflammatory occurrence, linked to the development of trichiasis.

Trichiasis (TT) is an extremely painful rubbing of the lashes against the cornea. At least, one eyelash rubs against the eyeball or evidence of recent removal of in-turned eyelashes. Timely correction of TT can prevent loss of vision, if otherwise, leads to corneal scarring.

Corneal Opacity (CO) indicated by the presence of easily

Figure 1: Follicular Trachoma (TF) stage. Figure courtesy of Hollman Miller, Vaupes, Colombia.

Figure 2: Inflammatory Trachoma (TI) stage. Courtesy of Hollman Miller, Vaupes, Colombia.

Figure 3: Trachomatous Scarring (TS) stage. Courtesy of Hollman Miller, Vaupes, Colombia.

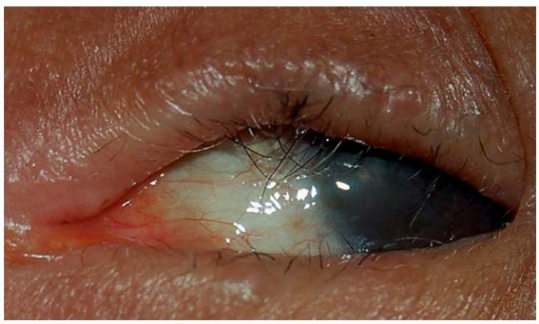

Figure 4: Trachomatous Triachiasis (TT) stage. Courtesy of Hollman Miller, Vaupes, Colombia.

visible corneal opacity. The pupillary margin, when viewed through the opacity is blurry. Here, the presence of follicular or intense trachomatous inflammation represents active disease.

Diagnosis of trachoma

Binocular magnifying loupes (x2.5) and adequate lighting are required for the examination of the eye for clinical signs of trachoma. Activities such as careful inspection of the lashes, cornea, and limbus, then eversion of the upper lid, and inspection of the tarsal conjunctiva are carried out. If available, a slit lamp can also be used [6]. The WHO definition of active trachoma is the presence of TF, TT, or both. *C. trachomatis* causes infection, yet its detection in cases of active disease is difficult. Due to the asymptomatic nature of this bacterium, it can be detected when there is no evidence of clinical signs of infection [33,34]. However, clinical signs of active disease do not necessarily mean that the conjunctiva is infected with *C. trachomatis*. Detection of the presence or absence of *C. trachomatis* is needed for subsequent research purposes [6]. Methods to detect infection from conjunctiva swabs include examining stained cells on slides, cultures of organism, detection of antigens, enzyme immunoassay, serology, nucleic acid amplification probes, and various nucleic acid amplification tests. Gallenga et al. [33] found that Polymerase Chain Reaction (PCR) testing was better in detecting *C. trachomatis* than culturing, immune fluorescent assay, and enzyme-linked fluorescent assay. Anthony et al. [6] reported that PCR is ideally suited for the detection of fastidious infectious organisms due to the fact that it does not rely on the presence of viable organisms. A PCR-based detection method was first published for the *C. trachomatis* bacterium [35]. Nucleic acid sequences used as targets in PCRs for detection of *C. trachomatis* include the Chlamydia cryptic plasmid (pCT) [36-38], omp1, coding for MOMP [35,37-40], the gene coding for 16S rRNA [36,38,41], and

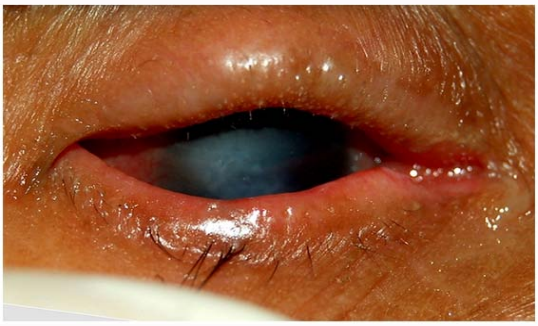

Figure 5: Corneal Opacity (CO) stage. Courtesy of Hollman Miller, Vaupes, Colombia.

omp2, coding for OmcB [42]. All of these are sequences are found on the *C. trachomatis* chromosome (except pCT), which includes 2 complete rRNA operons and single copies of *omp1* and *omp2*.

Treatment & control of trachoma

The SAFE strategy launched by WHO to help tackle and control the spread of the trachoma disease has caused a significant decrease in the number of people affected by the disease.

S- Surgical treatment

Different surgical procedures have been employed to treat trichiasis [43]. The WHO recommends Bilamellar Tarsal Rotation (BLTR), or lid rotation surgery for all patients showing clinical signs of TT, but it remains uncertain if patients with less severe TT can be treated with surgery. The lid surgery procedure is simple and sight-saving when done timely and correctly [44]. The affected lashes are epilated and examined until the disease progresses before undertaking the surgery [45]. Great effort has been put towards providing surgery at community level. Due to the limited availability of ophthalmologist, nurses have been trained to perform lid surgery [46], and no significant difference in clinical result was reported [47]. The prevalence of trichiasis in Nigeria has greatly decreased due to the intense application of this surgery method [26]. In Nigeria, surgery availability is poorly received due to financial constraints [19]. Patients have constantly showed signs of worry over sterilization of equipment in order to avoid blood-borne diseases [48]. Therefore, the WHO initiated a surgical checklist promoting the need to sterilize all equipment before surgery occurs [49]. TT clamp has been introduced as a new surgical instrument in standard BLTR surgery, a partial thickness incision is made via the skin and orbicularis, followed up with another incision via the conjunctiva and tarsus [50]. The TT clamp uses an integrated eyelid plate and makes one, full thickness incision. Although this procedure seems to protect against granuloma formation and some eyelid abnormalities, however, it surgical outcomes is low. Therefore, standard lid rotation surgery remains on the top list [50].

A study [51] designed to test the effect of trichiasis surgery on visual acuity found that the WHO – recommended BLTR procedure cased a significant improvement in visual acuity. Earlier studies [52,53] carried out one year after surgery had shown no improvement and no deterioration in visual acuity. This could be a result of recurrence of infection and not basically surgical failure. The study [53] with a decrease in visual acuity assessed the subjects from 3 to 4 years after surgery, when recurrence was likely. A recent study [54] in Oman, which is very close to achieving trachoma elimination, found

that the rate of blindness decreased significantly in people who had previous lid surgery.

In a 4-year prospective study Rajak et al. [55] trichiasis cumulative recurrence rates at 6 months, 1 year, and 4 years were 32%, 40%, and 41% with significant variation between surgeons in recurrence. The authors and others [54-56], suggest that surgical factors, such as technique and quality, were linked to early surgery failures, whereas late failures reflected an ongoing scarring process [50]. Quality assurance was thus suggested to monitor surgery outcomes by surgeons [57]. Because the overall trichiasis recurrence rate was lower than is normally reported for trichiasis surgery in the prospective study, which utilized the Posterior Tarsal Rotation Procedure (PLTR), the authors also suggested an evaluation of the WHO recommended BLTR procedure versus the PLTR procedure [55]. Another study in Ethiopia found that recurrence rates increased by surgical variables: longer incisions, their respective placement, and tightness of sutures. The authors also recommend monitoring and supervision, as well as regular retraining of surgeons.

A- Antibiotics treatment

Azithromycin and tetracycline are the antibiotics needed for the treatment of trachoma [58]. One annual dose of azithromycin over several years, depending on baseline prevalence, appears to eliminate infection, also, it is much easier to administer orally than the previous unsupervised use of tetracycline ointment for 4 to 6 weeks. In history, tetracycline ointment has been the choicest treatment option, but the discomfort associated with application of the ointment reduced patient adherence [59]. Therefore, this makes azithromycin the choicest antibiotics for trachoma control. The cost effect of azithromycin makes its widespread difficult. To solve this issue, in 1998, Pfizer Inc. and the Edna McConnell Clark Foundation founded the International Trachoma Initiative (ITI) – a scheme that sees collaboration between ministries of health, local government associations, and NGOs [60]. Since 1999, the ITI has coordinated the treatment of more than 250 million through the donation of Zithromax (azithromycin) by Pfizer [61]. Due to the fact that infection with Chlamydia trachomatis is not immediately known, when only people with known active trachoma are treated, a reservoir of infection remains in the community [62], consequently, this increases recurrence of reinfection. To combat this, the WHO recommends Mass Drug Administration (MDA).

MDA is the provision of drugs to whole populations in high-prevalence areas in order to treat active trachoma. MDA is to be administered in populations with a trachoma prevalence of greater than 10% among children aged between one and nine years, with a minimum of 80% of a community receiving antibiotics [63].

In 2010, out of the 30 local government areas surveyed for trachoma in Nigeria, seven were eligible to receive a donation from the ITI to provide MDA [64]. However, Nigeria has faced challenges in mapping out districts affected by trachoma due to low finance and limited resources.

Nigeria received its first donation from the ITI in 2010 to provide MDA for these seven local government areas. For a proper distribution, an antibiotic delivery initiative, whereby two to four Community Drug Distributors (CDDs) were selected to volunteer and execute the MDA strategy was carried out. In order to assess the distribution of azithromycin within a community, CDDs must register each member of the community who receives treatment. However, set-back in meeting the MDA target of 80% still remains. Certain states in Nigeria have been known to have an estimated antibiotic coverage of approximately 60% [64]. Furthermore, census data and population estimates are often inaccurate or unknown; leading to a discrepancy between the reported and true coverage rates achieved [65]. These difficulties have ultimately contributed to Nigeria's shortcomings in achieving GET2020. Considering these problems, emulating the antibiotic delivery system used in Malawi, who achieved the GET2020 target in 2019 is necessary [65]. This approach involves registering the population prior to beginning an MDA within a village. Following registration, antibiotics are administered using a static site method whereby residents collect the antibiotics themselves. Next, the occupants are interviewed, allowing for accurate calculation of coverage rates. Following this, any people who did not receive initial treatment are offered antibiotics [66]; emulating such proven strategies would likely lead to higher and more accurate coverage rates.

A single dose of azithromycin was found to be more effective than tetracycline ointment. One trial of MDA proved that such mass distribution treatment resulted in a reduced prevalence of active trachoma, and infection. The authors concluded that antibiotics reduce the risk and prevalence of active trachoma and ocular chlamydial infection in communities with people infected with trachomatis, but the size of the treatment in individuals remains uncertain. *C. trachomatis* infection has been shown to reemerge in communities that have been mass treated [67,68], as a result, WHO recommends that it is necessary to undertake repeated rounds (at least 3 annual treatments) of azithromycin treatment with 80% coverage to obtain prevalence ratios of less than 5% [69].

Reports have concluded that infants under the age of 6 months, not administered the azithromycin treatment are not the source of recurrence of infection [70] but children with the initially highest bacterial load may be the reason for recurrence [67].

Another study [71] tested if 2-day dosing in children with severe trachoma in Tanzania was more effective than 1-day dosing in preventing reinfection after mass treatment. Reduction of infection was significant in both groups. The 2-day dosing group had reduction at 96% with fewer high-risk children with infection after 6 weeks; 1-day dosing group at 80% which could therefore further reduce the reinfection of the community. This study thus supports WHO recommendation of more than one-time mass drug distribution.

Individuals from a community who do not participate in mass treatment, may act as a possible source of reinfection, which could come with many reasons: One study [72] looked at the non-participation of children in 2 treatment rounds in Tanzania and concluded their; *guardian risk factors* included being of a younger age; *Household risk factors* like family health problems that prevented members from going to the treatment and multiple young children. It was generally difficult to bring all household members to the mass treatment; *Program risk factors* included poor visibility, accessibility, and organization. Studies have therefore, shown the need for more-than-one-time MDA and reconsideration and readjustment of its methods to help decrease trachoma prevalence.

F – Facial cleanliness

Access to clean water facilitates hygiene and face cleanliness during face-washing, which result to a reduced prevalence of trachoma [73]. Serious inconsistency occurs in the availability of clean water in the Northern Nigeria, which could be related to poor rainfall

in the North [74]. This support the increase in the rate of infection in the region. A recent review [75], comparing face washing with no treatment, and face washing with antibiotics against antibiotics alone proved that face washing with tetracycline was helpful, but the evidence did not support face washing alone or combination with antibiotics. Currently, subsequent future projects targeted towards construction of water supply channels as well as its maintenance are being considered. The Federal Ministry of water resources in charge of WASH activities are on the verge of launching a new project known as Village Level Operation and Maintenance (VLOM) – aimed at establishing hand pumps which can be maintained at community level, establishment of chain of participation between government and communities, towards building and repairing boreholes. To further bring this to possibility, plans on teaching local mechanics and traders key repair skills are in view; plus, employment of facility porters charged with the responsibility of maintaining water facilities. A rise in trachoma prevalence can be combatted with these strategies in place [73].

E - Environmental factors

Because trachoma disappeared from most of the USA and Western Europe before antibiotics were discovered, it was reasoned that trachoma is eliminated by good personal hygiene practices within a sanitary environment. Reports have shown that over 20% of population in Nigeria practice open defecation, with higher rates occurring in the North [75]. Musca sorbens, one of the eye-seeking flies is responsible for trachoma transmission by breeding in human faeces. These flies prevail in areas where open defecation is commonly practiced [76]. After the formation of GET2020, Nigeria became a signatory of the program and announced aims to improve the availability of Water, Sanitation, and Health (WASH). Since the common cause for high rate of open defecation is lack of latrines, for this reason, an 'Open Defecation Free campaign [77], has been launched in Nigeria to combat the issue. Studies have shown that access to at least basic pit latrines have led to a significant decrease in numbers of eye-seeking flies connected with decrease in Trachoma prevalence [76,78].

Nigeria has also tried to implement Community-Led Total Sanitation (CLTS) approaches, with the primary aim of educating and raising awareness in a community about hygiene and its consequence [79]. India was able to make significant progress using these schemes [80] with increase in latrine usage of 30% [80,81]. Nigerian Government has stated that they will observe the same approach, and if maintained, Nigeria may be able to obtain the same result in India, thereby further reducing the rate of trachoma transmission.

Recent advances in diagnosis, elimination and treatment of trachoma

Cell culture, over the years, has always been seen as the best method of Chlamydia diagnosis, because of how its specificity is nearly faultless. However, the sensitivity seems to be imperfect, and has created the need for newer test methods, possessing more sensitivity.

• Review by Anthony et al. [6] suggests that newer test such as the nucleic acid amplification tests appear to be significantly more sensitive and highly specific than previous assays [82]. Investigations have proved that at least some of the apparent false negatives by the new test are actually true positives that have been missed by the culture test.

• Review by Anthony et al. [6] reported that a sequential sampling approach have been developed for a rapid trachoma survey by Myatt et al. it involves the collection and analyzing of data simultaneously. Combination of a sequential sampling method and random sampling may prove useful for mapping the prevalence of trachoma in large populations.

Following the SAFE strategy approach, several other schemes have been developed to help control the spread of trachoma:

• Since hand pumps are the main sources of water in rural areas, and only few of these pumps are functional, a Village Level Operation and Maintenance (VLOM) scheme has been initiated; aimed at constructing hand pumps for improvement in water supply and which can be managed at a village level [83].

• 'Open Defecation Free' campaign aimed at reducing the spread of trachoma through constructing latrines, including lavatories with soap. CLTS (Community-Led Total Sanitation) scheme has been implemented and aimed at sensitizing a community on hygiene [84], mostly the illiterate people, and those who have been bound by behavioral norms and cultural beliefs, in a community, the need for usage of the latrines.

Conclusion

Results from this review showed that there has been a significant decrease in the prevalence of active trachoma globally. Although there has been a significant decrease, its zero prevalence in Nigeria has not been totally achieved; hence the need for provision of resources for a population-based survey and mapping, targeted at eradicating this disease. Following the new target set for global elimination of trachoma as a public health problem in 2030, it calls for a scale-up in the implementation of the SAFE strategy, and also possible new ways of combating this disease.

Furthermore, in consistent with the hypothesis that diversity of *C. trachomatis* may be necessary for a high prevalence and recurrence of trachoma, Research have showed that prevalence of trachoma is linked with the genetic diversity of *C. trachomatis*. Hence, the need to understand the genome of this bacterium, as this will support future research geared towards the elimination of this disease, and increase creative efforts for vaccine production.

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