

A Retrospective, Multi-Center, Descriptive Cross-Sectional Study to Assess the Epidemiology of Noma: A Psychologically Debilitating Disease in Ethiopia

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ABSTRACT

Noma is orofacial gangrene, mainly occurring in debilitated children living in the developing world. It is among the Neglected Tropical Disease (NTDs) and an old companion of humankind. Noma is a disease of poverty, and its global distribution tends to mirror the economic deprivation of the regions. The condition is mainly located in tropical areas, which is the main reason for referring to the condition as a tropical disease. This retrospective cross-sectional study was conducted to assess the epidemiology of noma in Ethiopia. The assessment was based on a review of patients' medical charts. The medical charts were obtained from three noma treatment centers in Ethiopia. A modified Case Report Form (CRF) was used to record the needed clinical information for data analysis. The study reviewed 163 medical records obtained from the three centers. After data analysis, the onset of the disease was mainly reported among children younger than ten years. Yet the condition has also occurred in neonates, infants, children, and adults. The geographic distribution revealed the Amhara and Oromia regions as major areas of noma cases, with 32.4% (n=36) and 29.7% (n=33), respectively. Cheek, the lower and upper lips are the most frequently reported noma-induced facial defects. Indeed, more attention should be given to these geographic areas and children under the age of 10 years.

Keywords: Epidemiology; Noma; Cancrum oris; Ethiopia; Cross-sectional

Abbreviations: NTDs: Neglected Tropical Diseases; CRF: Case Report Form; WHO: World Health Organization; ANUG: Acute Necrotizing Ulcerative Gingivitis; DALYs: Disability-Adjusted Life Years; AIDS: Acquired Immunodeficiency Syndrome

INTRODUCTION

Noma was described in ancient Greek and Roman medical texts. The condition was reported by medieval and renaissance European writers. It was first described by Hippocrates in the 5th century BC when he discussed a destructive ulceronecrotic lesion in a patient's face, mouth, and airways. Historically, cases of Noma have been reported in Asia, Europe, South America, and Africa [1]. In the late middle ages, water canker and mouth canker were some of the many names for Noma. Subsequently, the Latin name Cancrum Oris emerged and remained in use,

even though contemporary physicians have already noted the difference between Noma and cancer. Between the 16th and 18th centuries AD, reports of Noma became more frequent throughout Europe. The condition was treated surgically. Conservative treatments, such as simple washings and extraction of loose teeth, were used to complement the newly developed surgical methods [2].

Furthermore, in the 19th century, a report showed the presence of Noma throughout Europe, and this disease was associated with malnutrition and childhood infection such as measles. In

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the wake of improved hygiene, socioeconomic status, and nutritional conditions. However, there were notable relapses during the two World Wars, particularly in prisons and concentration camps and, more recently, in immunocompromised patients [3].

Noma had almost disappeared from Europe and North America by the end of the 19th century. Yet, there has been an increasing incidence of Noma in underdeveloped countries [4]. In 1994, the World Health Organization (WHO) described Noma as a health priority and initiated an action program [5]. For various reasons, determining the actual epidemiological parameters of Noma is reported to be complicated. Reports revealed that the global incidence of Noma varies between 30,000 and 40,000 cases per year. Yet, 75% of the disease occurs in sub-Saharan Africa (the Noma belt). Because of the scarcity of treatment and the severity of the disease, most of the Noma patients die [6]. A recent preliminary study by the Swiss Tropical and Public Health Institute estimated the global burden of the disease between 1-10 million Disability-Adjusted Life Years (DALYs) [7].

Scholars argue that Acute Necrotizing Ulcerative Gingivitis (ANUG) is a precursor of Noma [8,9]. Today, most registered Noma patients are children under ten years of age, but cases in adolescents and adults may sporadically occur [10]. The vast majority of cases are living in the most deprived and remote regions of sub-Saharan Africa. Historically, Noma was most prevalent in areas known as the Noma belt of Mauritania, Senegal, Mali, Niger, Chad, Sudan, and Ethiopia. However, for several reasons, such as the Acquired Immunodeficiency Syndrome (AIDS) pandemic, there are also increasing numbers of Noma cases outside this Noma belt region. For instance, Noma occurs in Asia and Latin America, where health systems are reportedly weakened [11,12]. The virtual disappearance of the disease from the developed world was due to economic progress at the end of the nineteenth century. In countries or locations where the condition is prevalent, risk factors such as malnutrition, poor oral hygiene, deplorable environmental sanitation, close residential proximity to livestock, and infectious diseases (particularly measles) have been implicated [13]. Moreover, in recent times HIV infection is eroding the modest gains in nutrition and education, and there has been an upsurge in Noma cases [14]. The WHO estimated the annual global incidence of Noma at 140,000 and the associated mortality rate at 70% to 80%. According to other reports, the mortality rate of the condition is calculated to reach 85%-90% [7]. Noma is concentrated within the low- and middle-income countries of Africa, Asia, and Latin America. Africa not only currently maintains a disproportionate burden of Noma cases, but this avoidable and preventable condition remains a visible scourge of African children [15]. WHO estimated that more than 100,000 African children under the age of 6 may have Noma [14,16]. Noma is a highly psychologically morbid condition with no sufficient data on disease epidemiology, incidence rate, mortality rate, or risk factors are available globally. Ethiopia is not exceptional. Ethiopia is located in the Noma-belt, wherewith the disease is highly prevalent [17]. Therefore, this study was initiated to investigate the epidemiology of Noma in Ethiopia.

MATERIALS AND METHODS

Research design

A descriptive retrospective cross-sectional study was conducted to assess the epidemiology of Noma in Ethiopia. Theretrospective cross-sectional study, which sought to identify all confirmed cases and assess the epidemiology of Noma in this research, was based on the 2004-2020 clinical data recorded in Yekatit 12 Hospital, Facing Africa Ethiopia, and Harar Project Ethiopia, the three major Noma treatment centers in the country.

Sample and setting

This cross-sectional study was conducted in Addis Ababa. The medical records of patients diagnosed with Noma between March 2004 and December 2020 were considered for data analysis. The patients' files were obtained from Ethiopia's three major Noma treatment centers.

Instruments

The medical records of noma patients were reviewed to extract relevant clinical and demographic information. A modified Case Report Form (CRF) was used to collect the needed data. The CRF consisted demographic, personal, and clinical information. Accordingly, the patients pertinent data were recorded in the CRFs. These clinical and demographic data in the modified CRFs was used for data analysis.

Data analysis

The data management and analysis began with registering the clinical and demographic data into excel sheet. Eventually, SPSS (Statistical Package for Social Sciences) software was used to analyze the collected data.

RESULTS

The medical records of patients admitted to the three centers between March 2004, and December 2020 were included for review. Accordingly, 163 medical records were obtained from Ethiopia's three major Noma treatment centers. Of these, 68, 67, and 28 were obtained from facing Africa Ethiopia, Yekatit-12-Hospital, and Harar project Ethiopia, respectively.

Gender proportion of the Noma cases

There were more females (65%) than males (35%).

Age at the admission of the Noma cases

Age at the admission of the Noma case ranges from 1 year to 70 years. Thus 35% (n=57) were 11-20 years old and most frequent. The 11-20 age group was followed by 28.2% (n=46) and 16.6% (n=27), with 21-30 and 31-40-years old age groups, respectively. The 41-50, 1-10, 51-60, and 61-70 years old age groups consisted of 11% (n=18), 5.5% (n=9), 3.1% (n=5) and 0.6% (1) of the total Noma cases reviewed, respectively (Table 1).

Age groups by years at admission	Quantity	Percentage
1-10	9	5.50%
11-20	57	35%
21-30	46	28.20%
31-40	27	16.60%
41-50	18	11%
51-60	5	3.10%
61-70	1	0.60%
Total	163	100%

Table 1: Age groups by years at the admission of the Noma cases.

Residential regions of the Noma cases

Out of the total 111 medical records which reported the place of birth and residence of the Noma cases, 32.4% (n=36) and 29.7% (n=33) were from Amhara and Oromia regions, respectively. The Southern Nations, Nationalities people, and Somali regions are followed by 14.4% (n=16) and 10.8% (n=12), respectively. The least number of Noma cases were reported from the Afar region, with 1.8% (n=2).

Admission time of Noma cases in years

Of these total 163 medical records reviewed for the time of admission of the cases, 48.5% (n=79), 36.8% (n=60), and 14.7% (n=24) were admitted in between 2016-2020, 2010-2015, and 2004-2009, respectively.

Time of appearance of Noma

Out of these 111 medical records that reported the time of

appearance of the condition, 91% (n=100) had reported the occurrence of Noma between 1-9 years of age. A single case has reported the appearance of the disease since birth. The disease was seen during infancy in another single subject. Four Noma cases have reported the appearance of the disease, when they were 10 years old. The remaining four cases with the condition have reported the occurrence of the disease at 14, 18, 27, and 29 years of age.

Noma-induced facial defects pattern

According to the reviewed medical records, Noma affected the left side (n=85) of the face and mouth more than the right side (n=72). In general, 96.3% (n=157) of medical records have reported either left- or right-sided anatomical defects. The remaining 3.7% (n=6) of medical records have reported neither left nor right-sided facial deformities. The most common left, right, and neither left nor right-sided Noma-induced defects are described in Table 2.

Damaged facial anatomical region/s	Frequency of the defects			Total
	Left-sided	Right-sided	Neither right nor left-sided (complete loss)	
Cheek	19	5	-	23
Lower lip	10	9	-	19
Upper lip	10	6	-	16
Cheek, lower and upper lips	4	6	-	10
Cheek, oral commissure, lower and upper lips	5	6	-	11
Cheek and lower lip	4	6	-	10
Cheek, nose, lower and upper lips	5	6	-	9

Cheek and upper lip	5	4	-	9
Lower and upper lips	3	2	-	5
Oral commissure, lower and upper lips	4	2	-	6
Nose	3	3	-	6
Nose and upper lip	3	3	-	6
Cheek, nose and upper lip	1	3	-	4
Oral commissure and upper lip	2	2	-	4
Nose and upper lip	1	3	-	4
Cheek and oral commissure	-	3	-	3
Oral commissure	2	1	-	3
Maxilla and upper lip	1	2	-	3
Lower lip	-	-	2	2
Nose	-	-	2	2
Central lower lip	-	-	1	1
Central upper lip and nose	-	-	1	1
Chin and upper lip	1	-	-	1
Cheek and nose	-	1	-	1
Cheek, lower lip, nose and mandible	1	-	-	1
The infra-orbital region, oral commissure, nose, and zygoma	-	-	-	1
Hard palate, maxilla, nose, upper lip and zygoma	-	1	-	1
Total	85	72	6	163

Table 2: Noma-induced facial defects distribution by anatomy.

DISCUSSION

Until the early 20th century, Noma was familiar worldwide, including in Europe and the United States [18]. The disease virtually disappeared from developed countries following the massive economic development, except for cases seen in the concentration camps of Bergen-Belsen and Auschwitz and, more recently, in association with intensive immunosuppressive therapy, in some patients with Human Immunodeficiency Virus (HIV) infection and Native American children with severe combined immunodeficiency syndrome. Yet the disease is still highly prevalent in developing countries [19]. The WHO has compiled a global picture of reported cases; although African countries are the most affected, Asia and Latin America are not exempt [18].

Accurate epidemiologic data are lacking because Noma occurs predominantly in poor communities that do not keep health records and frequently have a nomadic lifestyle [20]. Also, the disease is often hidden by families who consider it an evil omen [21]. A more recent report estimates an annual incidence of 25,000 in the developing countries bordering the Sahara. But

these estimates reflect the tip of the iceberg because not more than 10 percent of affected persons seek medical care [7,22].

Noma is primarily observed among children younger than six years in countries with a low human development index, with the highest incidence occurring in the so-called Noma belt region. The region extends across West to East Africa, from Senegal to Ethiopia [23,24]. A study in Senegal revealed 1.2 to 4.2 cases per million annual incidence rate of Noma among children. A total of 96.9% of the children with progressive orofacial Noma had poor general health. The most frequently named associated diseases were anemia (48.0%), dehydration (18.0%), under-nutrition (14.0%), measles (4.0%), and diarrhea (2.0%) in this study [12]. In Senegal, the median annual number of Noma cases was 6 between 1981 and 1993 [25].

On the other hand, a northwest Nigerian-based study concluded that the incidence of Noma was estimated to be 6.4 per 1000 children [26]. Other studies in Nigeria estimated 1.6 to 8.3 per 100000 Noma cases [21,14].

A study led by the GESNOMA to identify the etiology of Noma in Niger identified 413 cases of the disease between 2001 and

2006 [27]. Furthermore, a six-year prospective case-control study conducted in Niger by the same group verified 82 cases of Noma to assess possible risk factors [13]. These and other studies have revealed the burden of the disease in Niger and the so-called Noma-belt [28].

Irrespective of the absence of actual scientific studies on Noma, some reports confirm the occurrence of the disease in Ethiopia. For instance, in three years (between 2007 and 2009), three visiting surgical teams from Guy's Hospital, Groningen University, had operated on 95 patients in Addis Ababa. Of these, 43 were patients with Noma [29,30].

Moreover, the UK-registered charity organization called Facing Africa reported that the teams of volunteer surgeons, anesthetists, doctors, and nurses who visit Ethiopia 2 times each year (usually February and October) on two weeks surgical missions used to operate on 50-55 children who survived the ravages of Noma since 2010. These reports suggest that the condition is affecting a significant number of children in Ethiopia [31].

On the other hand, Noma has rarely been reported from Asia. Literature has shown that the disease was reported in China, Vietnam, Afghanistan, India, Pakistan, Burma, Papua New Guinea, and Japan. An ad hoc study in Laos identified 12 cases of Noma from 6 of the 17 Lao provinces between 2002 and 2008. Furthermore, 8, 14, and 1 Noma survivors were reported in different provinces of Laos in 2003, 2004, and 2007 respectively [32]. Three cases of children with the condition were also reported in Afghanistan, India, and South Korea [33-35]. Though *Cancrum Oris* predominantly affects children in developing countries, especially in Africa and Asia, there have been reported cases in developed countries [36]. Recently, a 73-year-old black man with Noma and severe malnutrition reported in 2015 from urban Atlanta, Georgia, in the United States [18], Noma in a patient with HIV in the United Kingdom [37], and an elderly immunosuppressed Italian patient with Noma have revealed possible sporadic cases of the disease in developed countries. Moreover, these case reports have shown that Noma could also occur in old age groups [38].

The global incidence of Noma was estimated to be 30,000-40,000 cases annually [9]. Three-fourths of these cases are still in sub-Saharan Africa (the Noma belt region) [39]. Accordingly, the condition is mainly located in tropical areas, which seems to be the main reason for referring to the condition as a tropical disease [16]. Similarly, most of the patients admitted to the three Noma treatment facilities were from rural and disadvantaged areas of the country. Only 2.7% (n=3) were from Addis Ababa, Ethiopia's capital city. Yet, many drinks, river and well water, education and health services are limited, and many live with domestic animals. A tropical climate characterizes the Afar, Somali, Gambella, and Tigray, part of the Amhara and Oromia regions reported in the medical records. These regions constituted nearly 73% of the total patients admitted to Ethiopia's three Noma treatment facilities. Nevertheless, the Amhara and Oromia regions constitute 32.4% (n=36) and 29.7% (n=33) of the total Noma cases registered in the three treatment facilities. The increased number of Noma cases in the Amhara region could be explained in terms of the area's relative

proximity to the three Noma treatment centers and because the region had hosted the famous famine in the country's history between 1984-1985. Furthermore, the fact that the region is the second most populous in the country could also explain why it has habituated more Noma cases.

In this regard, further investigations need to be carried out.

Noma occurs primarily in children but has also been described in neonates. The disease affects adults and chronically ill people. Similarly, 90% of the total 111 medical records, which documented the time of occurrence of Noma, revealed patients aged between 1 to 9 years. A single case has reported the appearance of the disease in infancy. Another subject has experienced Noma since birth. Of these, two cases have reported the occurrence of the disease at the end of their 20s. Accordingly, most reported Noma patients in this study are children well under ten years of age, but cases in adolescents and adults have been reported sporadically.

CONCLUSION

Countries in the Noma-belt area, including Ethiopia, are affected with a much higher Noma burden than any other geographic locations in the world. Yet, this psychologically debilitating disease has gained little attention and there are no considerable scientific studies in the region. In this case, the findings of this study could fill the scientific knowledge gap and be used as baseline data for further in-depth investigation. Consequently, policymakers could use the epidemiologic results of this study to allocate disease prevention resources economically and spatially across the country.

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