Risk Factors Responsible for the Spread of Meningococcal Meningitis: A Review

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Abstract
Meningococcal meningitis is an air borne disease that has affected every region of the world for over a century now. The disease has a strong relationship with some certain factors which are categorised into socioeconomic factors, social behaviour, climate and environmental factor, demography, respiratory tract disease and geographical localization. In most countries of the world there are sporadic cases from time to time, which implies that the meningococcal bacteria is endemic there but at low level. There is an area that spans sub-Saharan Africa called the meningitis belt where large epidemics occur regularly. The paper describes the various factors that have influenced the spread of the disease in different regions of the world. Risk factors for meningococcal meningitis disease were reviewed. The paper has clearly identified the most important factors like the socioeconomic level, climate and environment, urbanization level, geographical localization, respiratory Tract/Viral Infections, social behaviour, demography and recreational spaces as the cause of the spread of meningococcal meningitis. Having the knowledge of how these factors influences the spread of the disease will go a long way in helping in the prevention strategies by the relevant authorities.

Keywords Risk factors, Meningococcal Meningitis, Epidemics

Introduction

Meningococcal Meningitis which is also known as cerebrospinal meningitis is a contagious disease which is caused by *Nissearea meningitis.* Most times the outbreaks starts with severe headache, throwing up and difficulty in turning the neck which eventually leads to comma in the space of few hours[1]. The destructive nature of a typical case that is not treated is 80%. Meningococcal meningitis disease is very significant cause of death and sorrow all over the world[2 3].

The developing countries in the world have accounted for the large estimates of the occurrence of meningococcal disease; the percentage of carriers of the disease and those that have been hit by it is between 1:100 during epidemics to 1:1,000 in endemic areas[4]. It means that people can build up a natural immunity of this disease in region where there is high risk of vulnerability to the organism that causes it. Majority of the people travelling from regions where the endimicity is low to high endemic regions most especially those people living in Europe but are visiting some areas in Africa, Asia, parts of South America and Middle East will be exposed to meningococcal disease[5]. The paper seeks to describe the various factors that have influenced the spread of the disease in the different regions of the world.

The Global nature of Meningococcal meningitis

After the 2nd World War, the extensive outbreaks of meningococcal disease inflicted majorly the countries in the sub-Saharan areas within the "meningitis belt"[6]. Regularly the disease devours part of these countries. Over 340,000 occurrences and more than 53,000 casualties were accounted within 1951-1960 from this region of the globe when the total number was just 35 million. On the other hand, epidemics of meningitis are a global problem and can touch any area in the world in spite of the climate. In the 1960s, the disease was seen as a very severe health risk in some of the tropical countries but not a severe health risk in North American and countries in Europe, but this conception changed in the period within 1970s [6]. A report [7] indicates that meningococcal epidemics manifest all over the world, and there is an increase in the occurrences of the disease within some countries of America, Europe and Asia displaying an epidemiological impression described by with frequent epidemics and consistent endemic sporadic occurrences of the disease. Between 1970 and 1971 there were cases in Italy, Portugal, Spain, Yugoslavia and Belgium, Argentina was in 1974, United Kingdom 1974 - 1975, and France was 1973 and 1978 with a sharp increase of incidence. There were outbreaks of *M. meningitis* at Finland, Mongolia and the USSR in the year 1973 and 1974, Norway, from 1975 all through to 1980s. Algeria and Chile in 1979, Vietnam and Rwanda were 1977 - 1978, with frequent outbreaks also reported from Brazil. There was an epidemic tide in 1980s of meningococcal disease which diffused all around the regions in Asia (India) about 6,133 outbreaks in 1985 in New Delhi; case fatality rate (CFR) was 13%, and 25% of cases urgency in the newly born. In Nepal (Katmandu valley) from 1982 – 1984, was about 103 occurrences in 100,000 populations, and in Africa specifically cases were found in Mali, Nigeria, Burkina Faso and Niger [7]. The epidemics of Meningococcal disease were also accounted in Cuba in 1982 to 1984 and Chile was in 1986 and 1993 [8].

In a study of the spread of Meningococcal meningitis [9] shows that the outbreaks of the disease globally are not the same. Some regions have low endemicity, like the industrialized regions have a yearly outbreak amount of about 1-12 in 100,000. There is a very strong contrast with the yearly outbreak amount in the developing countries like the "African Meningitis Belt", which is as high as 25 in 100,000. Major epidemics arises vary rapidly, and peaks within some weeks, and it is due to the pattern of the transmission of the disease which is from one person to another person through the droplets of respiratory or the secretions from the throat of the carriers [4]. Frequency rates usually remain high for 1 - 2 years after there was an epidemic. The epidemiology of meningitis is always changing, it should be noted that places where the meningitis is endemic are also vulnerable to regular epidemics. When there is an attack, rates reach up to 1,000 per 100,000[4].

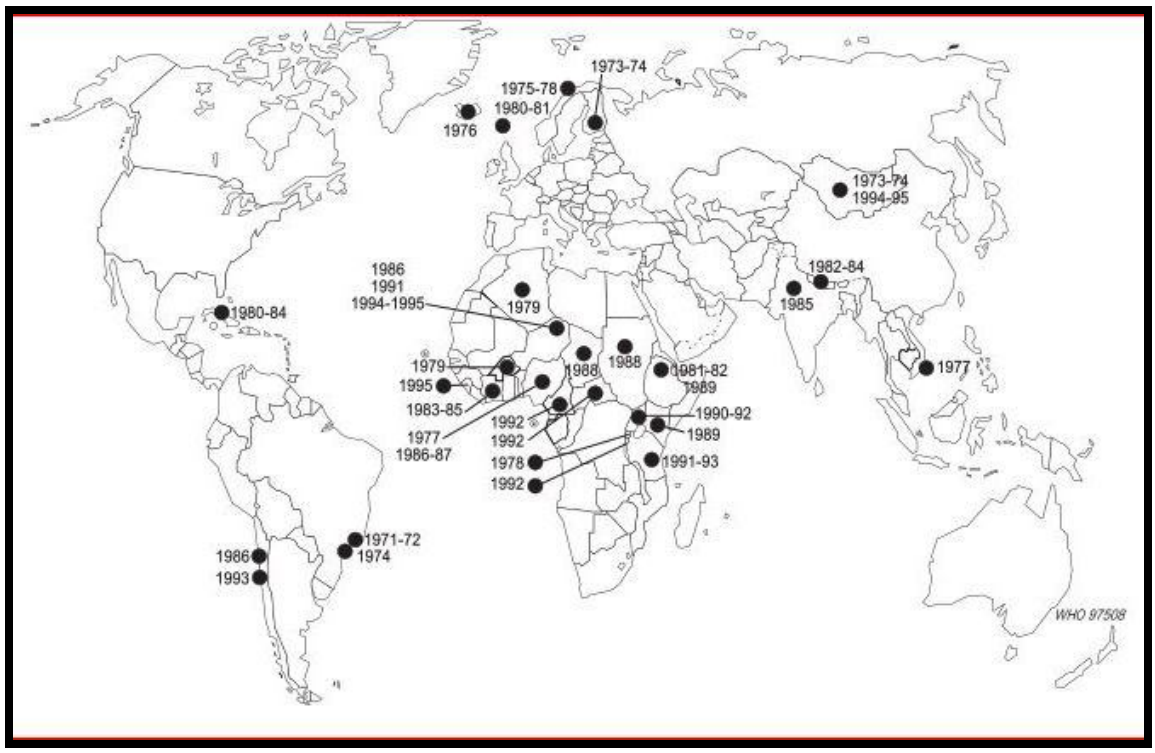

Figure 1: Epidemics of Meningococcal meningitis in the world

Source: WHO, (2000)

Figure 1 shows the cases of Meningococcal meningitis in the different parts of the world at different years. The cases appear more predominant in Africa and especially at West African meningitis belt. Figure 2 shows the African meningitis belt, a region where there are constant cases of the disease year in year out.

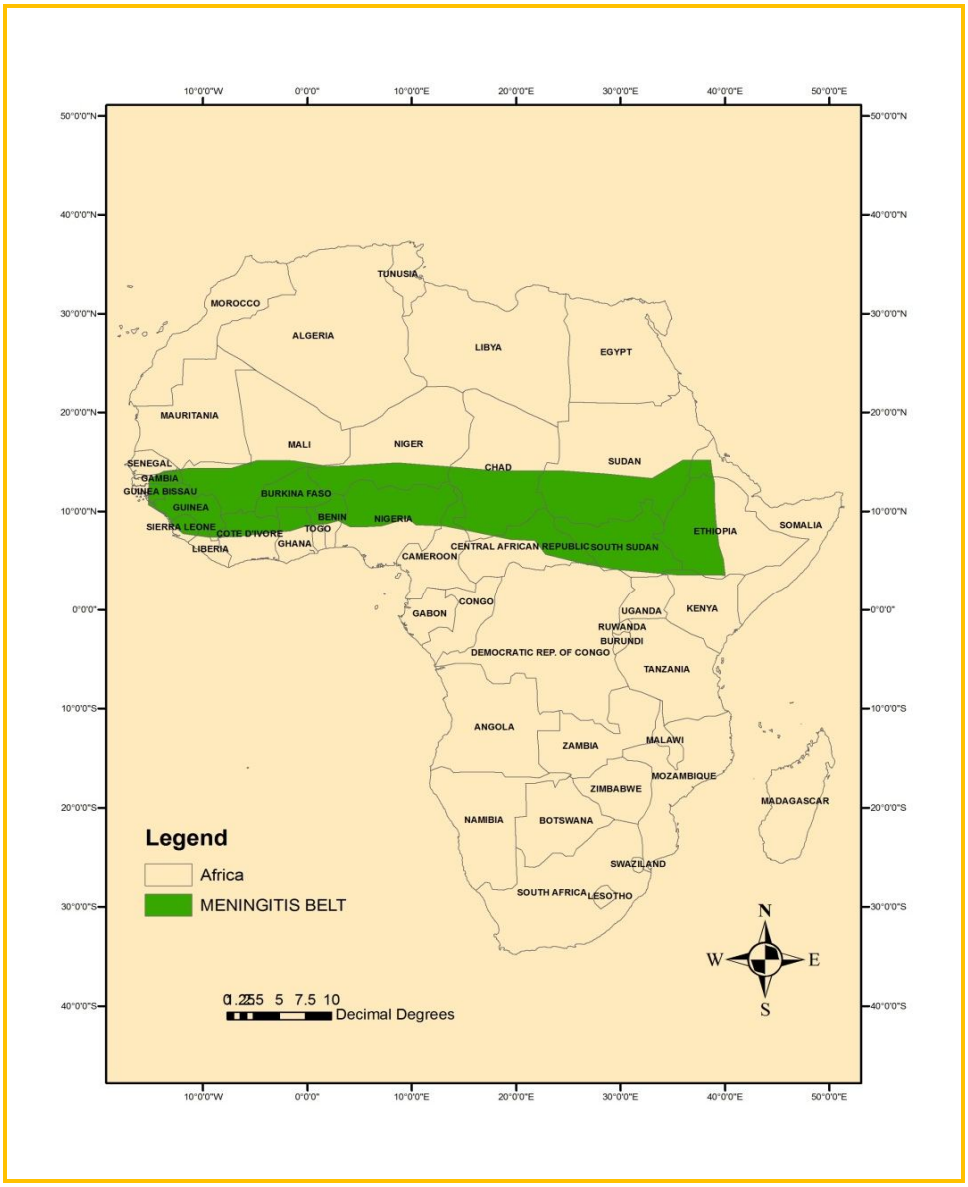

Figure 2: Map of West Africa Showing the meningitis belt

The highest reported meningococcal meningitis disease epidemic in the history of the world was in 1996 and most of the cases were found in Africa[10 11] .In that, over 250,000 cases with 25,000 deaths that were reported to World Health Organisation (WHO). From 1996 to 2002, over 223,000 meningococcal meningitis disease cases were recorded all over the world but most of the cases were from Burkina Faso, Chad, Ethiopia, Mali, Nigeria and Niger[11 12].

Extension beyond the African Meningitis belt

Outbreaks of meningococcal meningitis extended to other African countries. There were epidemics towards the end of 1980s and early 1990s at Burundi, Central African Republic, Kenya, Rwanda, Uganda, Tanzania and Zimbabwe are all the countries where the disease spread outside the usual boundaries[7]. There were over 2200 cases of meningococcal disease with 200 deaths around the

great lakes region (countries listed above) in 2002,[13]. A report[14] indicated that Cote d Ivore, Togo, Central African Republic and Cameroun had epidemics expanding to new districts southwards to the Sahelian axis. The reason for the expansion of meningitis belt is as a result of low rainfall and absolute humidity in the new epidemic districts [15].

Methods

A complete review of the scientific literature in Google Scholar, Medline, Pubmed, Science direct Scopus and Web of Science was carried out in January 2012. Some relevant materials were also found using Proquest Dissertations, Google, Theses, and, public health department websites, World Health Organisation website and library catalogues. The search methods involved using the controlled terms and free text; it was also adjusted based on the database being searched. Generally, three main terms were searched: (1) Meningococcal meningitis; (2) Risk factors for the spread of Meningococcal meningitis (3) Epidemiology of Meningococcal meningitis. Bibliographies were reviewed to locate additional relevant material and to search using Scopus, Web of Science, and Google Scholar. The references were only in English language.

Results

Meningitis Disease and Socioeconomic Level

There are many factors that have been proved that are responsible for the outbreaks of meningitis in different regions of the world. One of those factors is the socioeconomic factor. So many studies have shown that this factor has a significant role in these following ways:

Poor Housing Condition and Household Overcrowding: A lot of studies that have been carried out have shown consistent evidence that meningococcal disease has a direct relationship with poor housing condition and household overcrowding [16-19] . A study to buttress the fact that poor housing conditions and overcrowded household are more vulnerable to the outbreaks of the disease was also conducted[17]. In the study, they found out that the incidence risk for all cases was about 2.4 times greater in the areas that have poor housing conditions. But the greatest association was between meningococcal cases and overcrowding. Another study[18] on the Geographic's and socioeconomic variation of meningococcal disease shows clearly that the risk of the disease in the most deprived areas was twice that of the less deprived area. But earlier studies[20 21] discovered that there was no significant evidence between meningococcal cases and overcrowding but it becomes only a significant factor in the spread of the disease when overcrowding goes beyond a threshold.

To further prove that overcrowding has a significant relationship with meningococcal disease, another study[20] showed that close contact and overcrowding in an environment influences the outbreak of the disease. This study supported the discovery of an early study carried out [21] about the military recruits in the First World War and also another research on civilian population [22]. Another study carried out [16], which was also in agreement with overcrowding as a factor to the attack of meningococcal disease. They found out that if a family are dwelling in an average sized house of six rooms, if there is any increment in the number of adolescent or adults by one, there

will be a high tendency of about 50 percent increase in the risk of meningococcal disease for a child that is living in the same household. Also another study[23] on freshmen living in the dormitories in the US was conducted. The study proposed that freshmen living in the dormitories have an averagely high risk of disease than the other US college student. A similar research [24] shows how living in a crowded environment can lead to the meningococcal disease. It discovered that dormitory for students because of its crowded nature leads to outbreaks of the disease.

However, a similar study was carried out in South Korea[25] it was found out that there was no significant relationship between Meningitis and living in a crowded hall like the dormitory. This finding is consistent with an earlier study[26], which did not find any relationship between crowded environment and meningococcal disease.

Table 1: Studies on poor housing conditions/overcrowding and meningococcal meningitis

Region	Factor	Outcome	Country	References
United Kingdom	**Poor Housing Condition and Household overcrowding**	**The disease is very common in the most deprived settlements.**	**Urban and Rural areas in United Kingdom**	**Olowokure et.al., (2006)**
		Socially deprived areas were more vulnerable to the disease.	**Gwent in the United Kingdom.**	**Fone et.al. (2002)**
		When overcrowding goes beyond a threshold.	**Wales in United Kingdom**	**Davies et.al., (1996)**
		Significant relationship between overcrowding and the disease.	**West of England**	**Stuart et.al., (1989)** **Stanwell-Smith et.al. (1993)**
		Overcrowding at the military camp.		**Glover (1920)**
			South England	
		Overcrowding		**Baker et.al. (2000)**
New Zealand			**Auckland, New Zealand**	
		Overcrowding		**Tully et.al. (2006)**

United Kingdom			**England**	
		Overcrowding		**Bruce et.al. (2001)**
United States of America			**College Students in the United States of America**	
		Ovecrowding as an insignificant Factor for the Disease.		**Durey et.al. (2011)**
South Korea			**Students in the University Dormitory in South Korea**	
		Overcrowding as an insignificant Factor for the Disease.		**MacLennan et.al. (2006)**
United Kingdom			**United Kingdom**	

The table above shows the various studies in different countries, which have been carried out on how poor housing conditions and overcrowding has influenced the spread of Meningococcal disease. Since some of the studies show that living in the dormitory and in crowded environment did not correlate with spread of the disease, then the reason for spread of the disease in crowded areas could be as a result of poor conditions of the building and lack of proper ventilation and sanitation.

Education and Income Level: Education and income level are indicators used to measure the socioeconomic condition of a particular area [27]. In other words, the socioeconomic condition is proportional to the level of education and also the income level. A rich man will not prefer to live in an area that is deprived of facilities and services; he would prefer to live in area that has adequate facilities and services since he can afford it. The level of his education and exposure will guide him in the choice of where to live. Based on other studies [29 30], their studies suggested that maternal education is an indicator for health of a child in the Czechoslovakia populace. Studies that have been carried out in US has consistently shown that African-American origin, low income level, low maternal education and other negative social characteristics were closely linked with increased risk of the disease[29]. Generally speaking, studies consistently suggested that low socioeconomic condition increases the risk of meningococcal disease[30].

Table 2: Studies on education/income levels and meningococcal meningitis

Country	Factor	Outcome	Region	References
Czech Republic	**Education and Income Level**	**Lack of education**	**Czech Republic**	**Kriz et.al., (2000) Bobak et.al., (1994) Koupilora et.al., (1991)**

United States of America		**Low Income and lack of education**	**United States**	**Bobak et.al., (1999)** **Kriz et.al., (2000)** **Rosenstein et. al., (2001)** **Burgess (2006)**

Table 2, shows more studies that have been carried out on how low income level and low educational level has influenced the spread of Meningococcal meningitis. It indicates that poor income and educational levels are key factors in the spread of the disease.

Meningitis and Demography

The age and sex are other major factors in the spread of meningococcal disease. Studies have shown that the attack is much more common in some particular age target and at the same time some authors proposed that the attack rate is not same for both sexes. A study in Mali, West Africa [31] revealed that boys that are within the age bracket of 5 to 15 years are more vulnerable to the disease due to some of their habits. Boys in Mali sleep beside each other, and the nocturnal closeness facilitates the spread of the disease within them. It goes in line with the findings of other studies carried out, [33 34] that the cases of the disease is more common within this age limit.

Some other studies [34 35] indicated that children below the age of five were more vulnerable. It also goes in line with the study of that children that are below five years are more vulnerable to meningococcal disease especially those ones living at the deprived areas[34]. To further buttress the fact that children between the age of 0 to 5 are more vulnerable, a study was conducted on the Meningococcal disease and prevention in Hajj, it was observed that 58% of the reported meningococcal disease targeted age zero to five, out of which 39% are within zero to two years old [35]. In another similar and a recent study [36] on the meningococcal disease in the Middle East and North Africa (MENA). Their findings showed that meningococcal disease in that region seems to be predominant in children that are between ages zero to five years old, though the disease sometimes affects older age group.

On the other hand there were findings [37] in another study that the prevalence rate is low in children but it increases as they grow to adults to a peak of 19 years old and later starts dropping in older adulthood. The possible reason for the high case rate in teenagers may be due to some other factors like social behaviors and contact patterns. It was noted [33] that meningococcal disease is inversely related to age; about 49% of the cases appear in children that are less than two years of age. During epidemics, older children are more vulnerable to the disease. It was also indicated in a study [23] that activities and events that increases the risk of meningococcal disease in adolescents are different from that of the childhood, probably that is the reason why the adolescents and young adults are more vulnerable to the disease. Activities like smoking, intimate kissing and clubbing are the things that exposes them to the attack of the disease[29].

Sex: Many studies that have been carried out in the past to ascertain whether there is a difference in the attack rate between male and female for meningococcal disease did not find a significant

difference. Studies [39 40] revealed that there was no significant difference at the rate at which meningitis disease affects male and female. But a study[40] on household contacts of meningococcal disease in Nigeria observed that the general prevalence of the risk was not influenced by sex, but the prevalence of the risk was in people of 20 years and below was significantly higher in men than in women. Likewise, there was a switch found in those people that are over 20 years old with prevalence of the risk significantly higher in women than in men. This confirms the study that was conducted in Mali, which shows that males between a particular the age group are more prone to the attack and it is due to some of the habits of the young males which facilitate the spread of the disease [31]. Another [41] similar findings was made that the risk of getting infected with meningococcal disease is not the same for male and female, the findings indicated that males are at a higher risk to get infected than the females. This could be as a result of the social patterns between men and women in the different traditional settings [42]. In some traditional settings like in northern Nigeria, most women are restricted to doing their daily living activities within their homes.

Table 3: Studies on demography and meningococcal meningitis

Region	Factor	Outcome	Country	References
Europe	**Age and Sex**	**Teenagers and young adults are more vulnerable.**	**Wales, United Kingdom**	**Davies et.al. (1996)**
			England	**Tully et. al.(2006)**
		Children below the age of five.	**Gwent, United Kingdom**	**Fone et. al., (2002)**
				Borrow (2009)
America		**Activities that is associated with the age group.**	**United States**	**Rosenstein et.al., (2001)**
Middle east		**Children less than one year**	**Saudi Arabia**	**Al-Mazrou et.al., (2003)**
		Children less than one year	**Saudi Arabia**	**Williams et. al., (2004)**
		The peak age for the attack is nineteen years.	**Review (world)**	**Christensen et.al., (2010)**
World		**Older children are more vulnerable**	**Review (world)**	**Joachim and Nadel, (2010)**

Africa	Sex	No significant relationship between the sex and disease.	Northern Nigeria	Blakebrough (1982) Emele et.al., (1990)
		Attack on male is higher than in females.	Eastern Ghana	Gaugneux et.al., (2002)
		Attack on male is higher than in females.	Nigeria	Hassan-King et. al., (1979)
		Attack is more in women	Review (Africa Meningitis Belt)	Trotter and Greenwood, (2007)

The table above shows other studies that have been carried out by different authors and at different countries in the world on how age and sex are seen as factors that influences the spread of meningococcal meningitis disease. From the various studies reviewed it seems the age group that is most vulnerable to meningococcal meningitis disease is between 0 to 19 years which shows that the disease is inversely related to age. The studies also indicates that, it is the activities at different age bracket that influences the spread and not because it is male or female. There are some activities that bring people together which is very common with the young male, that is why the cases is higher in males than in females.

Social Behavior

So many studies have shown that social behavior is another factor that influences the meningococcal disease. The social behaviors that are influencing factors are smoking, clubbing, intimate kissing and sexual activity[27].

Smoking: Studies have been carried out about smoking as a risk factor to meningococcal disease. Among such, is a study [20] on Smoking, the environment and meningococcal disease in Britain. In the study it was discovered that exposure to cigarette smoke and meningococcal disease in young children has a strong relationship, which is very similar to the findings in some studies that were carried out[44 45] in Britain. Another similar study was carried out in Wales[45] on the risk factors of Meningococcal disease in a school during a community outbreak of the disease. In that study, personal smoking was found to be statistically significant which further helps to explain the reason why there were more older girls found with the disease because they smoke more.

Generally speaking, tobacco smoke [19 47] is a risk factor for meningococcal bacteria carriage which means exposure to people that smoke will likely increase the risk of the exposure to the pathogen. Another study [47] at Edmonton, Alberta outbreak of 1999-2002. The study found out that passive tobacco smoke exposure inside the home or outside was very significant factor for meningococcal disease. This study was consistent with studies that were carried out [48-

50][49][50] in which it was also discovered that the exposure to smoke for the child is more from the mother than the father or any household member. Since the child is closer to the mother than anyone else in the house. The exposure of the smoke for the child is a strong risk factor which is in line with a study [16 48] in the United States, which proposed that maternal smoking contributes much more to tobacco smoke exposure in children than the smoking habit of the father. To further buttress this point, a study in Spain [51] on the risk factors for invasive disease among the children. Their findings showed that smoking at home was a modifiable risk factor, if the rate at which people smoke is reduced there is high tendency that the number of cases for the disease will be reduced.

The reason why smoking tobacco is a risk factor is because the smoke reduces the defenses of the nasopharyngeal mucosa against the invasion of meningococcal disease [20 45 48][48]. However in a study [16] in Auckland, New Zealand discovered a weaker relationship between meningococcal disease and smoking tobacco. Also, another study [23] in a college in the United States found out that tobacco smoke does not have any association with meningococcal disease, the reason could be as a result of the low number of the people exposed to tobacco that were used for the study.

Another puzzling finding in a recent study in Kenya, Africa[52] was that, one of the risk factors that were identified in the multivariable analysis is cooking with firewood outside the house. It is puzzling because smoking being a well-known risk factor for meningococcal disease [53] should have greater relationship when cooking is done in an enclosed and unventilated room than outside the room. The reason for this is poorly understood.

Clubbing and Bar: Another Social behavior that is a risk factor is clubbing and going to bars. A number of studies have been undertaken to investigate the relationship of meningitis risk and clubbing/bar. A study conducted [54] at a University residency for the undergraduates in the United States shows that Meningococcal disease has a link with Clubs and Bars. Due to the fact that disco halls and bars are mostly crowded, and crowded conditions aids in droplets transmission and adds to the vulnerability of the disease on people that smoke and are exposed to the meningococcal infection[55]. Consequently, excessive smoking in the bar may be the strongest reason for the association of the disease with bar patronage. In Argentina, a study [56] discovered that people that patronize nightclubs and bars are more vulnerable to get infected with the meningococcal disease which is also consistent with the findings that attending large social gatherings for a long period of time is a strong risk factor, most likely through exposure of people that are infected with the disease [20]. In Edmonton Alberta, it was discovered that exposure to bar environment and places of large gatherings are significant risk factor of the disease, because the condition in such places aids the respiratory droplet transmission and exposure to passive tobacco smoke [47].

Table 4: Studies on social behavior and meningococcal meningitis

Region	Factor	Outcome	Country	References
Europe	**Smoking**	**Cases are higher on those exposed to smoking.**	**Czeck Republic**	**Kriz et. al., (2000)**
			Britain	**Stanwell-Smith et. al., (1993)**
			Britain	**Staurt et.al., (1986)**
			Wales, United Kingdom	**Durey et.al., (2012)**
			Spain	**Pereiro et.al., (2004)**
America			**Alberta, Edmonton Canada**	**Davies et.al., (1996)**
			USA	**Moodley et.al., (1999)**
Asia			**Auckland, New Zealand**	**Honish et.al., (2007)**
			South Korea	**Baker et.al., (2000)**
Africa			**South Africa**	**Haneberg et.al., (1983)**
	Cooking smoke	**Inhaling smoke during cooking, outside the kitchen tends exposes people to the disease than cooking within an enclosed room.**	**Kenya**	**Mutonga et.al., (2009)**
America	**Clubbing and Bar**	**Attending large gatherings enhances the spread**	**United States of America**	**Imrey et.al., (1996)**
			Aregentina	**Cookson et. al., (1998),**
			Canada	**Honish et.al.,**

				(2007)
Asia			**Auckland, New Zealand**	**Baker et.al., (2000)**

Table 4 shows other various studies carried out at different locations in the world which point to the fact that smoking, clubbing and attending bars are significant factors that influence the spread of meningococcal meningitis.

Respiratory Tract/Viral Infections

A number of studies carried out on the risk factors of meningococcal disease indicated that respiratory tract and viral infections are very significant risk factors. A Study on a cluster of meningococcal disease on a school bus after an epidemic of influenza [57]. The study shows clearly that influenza infection contributed to the outbreak of the disease in the bus because more than half of the school children had influenza prior to the outbreak of the disease. The study was similar to the findings in a related research in Greece, which found out that respiratory tract infection is a significant risk factor in meningococcal disease[58]. In the study, it was discovered that over 50 % of the people that had meningococcal disease had respiratory tract infection. The study in England [45] also revealed that respiratory tract and viral infections were risk factors to meningococcal disease. A research conducted in Kenya, Africa discovered that preceding upper respiratory tract infection is a significant risk factor for the disease. The studies shows consistency, however, another study in Northern Ireland pointed out that, respiratory tract infections were not seen as a risk factor to the spread of meningococcal disease [59].

Table 5: Studies on respiratory tract/ viral infection and meningococcal meningitis

Region	Factor	Outcome	Country	References
Africa	**Respiratory Tract/Viral Infections**	**Preceding a respiratory tract infection increases the chances of getting the disease of meningitis.**	**Niger**	**Mutunga et al., (2009)**
Europe			**England**	**Davies et al., (1996)**
		Respiratory tract infections were not seen as the risk factors	**Northern Ireland**	**Dunlop et al., (2007)**
		Influenza influences in the outbreak of the disease.	**Greece**	**Blackwell et al., (1992)**
America		**Having respiratory tract infection is a risk factor in getting infected with the disease.**	**United States of America**	**Harrison et al., (1991)**

Table 5: shows the studies that were carried out which shows the relationship of meningococcal meningitis disease and respiratory tract/viral infections. It clearly shows that it also influences the spread of the disease.

Climatic Conditions

Climatic conditions play a major role in the seasonal rise of the meningococcal disease [60]. A number of studies have shown that climatic conditions are a significant risk factor to meningococcal disease in these following ways;

Climatic and Geographical Location: Lapeyssonie, [60] defined meningitis belt that it is in between latitudes 4° and 16° north which coincided with the 300-1100 mm mean annual rainfall isohytes from the south of Sahara, in which the semi-arid sub-Saharan Africa and Sahel is enclosed within. Within this area random attacks takes place in seasonal yearly cycles while epidemics of meningococcal disease with very high magnitude, occurring at large intervals in an inconsistent order [6] and the epidemics are mostly during the dry season which abruptly stops immediately the rains starts [61]. The countries within the meningitis belt include Ethiopia, The Gambia, Benin, Cameroon Burkina Faso, Chad, Ghana, Niger, Mali, Senegal, Nigeria and Sudan. The meningitis belt is characterized with low temperature at night during the dry season which is about 10°C and also there is a strong impact of harmattan (strong wind blowing particles and dust from Sahara) on the nasopharyngeal of an individual mucosa, which allows the meningococcus to attack the individual [60]. A study on meningococcal disease in Zaire,[62] suggested that areas that are humid throughout the year have low disease rate. Very few epidemics were accounted from the areas that are densely forested and humid even at the time that the neighboring areas within the meningitis belt were going through the attacks of the epidemics[63 64]. An example of this is found in Nigeria; very few and scanty cases of meningitis are being reported from the southern part compared to the northern part that is always experiencing the epidemics.

Environment: Land cover has a strong influence on the risk of transmitting meningococcal disease. Meningitis belt is characterized with semi-arid climate, south from the Sahara with little rainfall as compared to the humid zone that has high rainfall [60]. The region generally has short grasses and there are no thick forests. A study[64] indicated that land cover type is one of the factors that are independently associated with the locations of meningococcal disease and land cover can be used to distinguish between areas that have high and low risk for the disease. It was also discovered that areas that are humid throughout the year have low disease rate. Areas that has been ravaged by deforestation activities eventually results to erosion which favors the ventilation of aerosols and different kinds of micro particles (dust) which increases the risk of transmitting meningococcal disease infection[59].

Relative Humidity and Temperature: A result of a study[64] indicated that relative humidity was a very significant risk factor for meningococcal disease. The study was based on a model for humidity and land cover type, to be described in terms of the characteristics of the baseline. The study was able to propose a risk map for the experiences in epidemics of meningococcal disease. It was discovered in the study that the most significant factor that is linked with the distribution of epidemics was relative humidity. Areas that do have much difference for wet and dry seasons

hardly have epidemics compared with those that have contrasting seasons. A positive relationship was proposed in a study between humidity and interannual variability of meningococcal disease [65], which is consistent with one of the early works on risk factors for epidemics of Meningitis [63], he suggested that low humidity is a determinant for the epidemics. In a study carried out in Nigeria, Africa, it was discovered that during the epidemics in northern Nigeria of 1996, the temperature at that time was over 40°c suggesting that it was also a determinant factor to the disease [66].

Rainfall: Rainfall is another risk factor to meningococcal disease. [60] described the meningitis belt as having 300-1100mm mean annual rainfall which is seen as one of the determinants influencing the disease. Many studies have shown that, in African meningitis belt, the outbreaks are commonly in the dry seasons when there is no rainfall, but suddenly drops at the onset of the rains [66 67]. A study in Africa [61] revealed that the spread of the disease stops immediately the rains starts, which points to the fact that rainfall is a risk factor on the disease.

Table 6: Studies on climate and meningococcal meningitis

Region	Factor	Outcome	Country	References
Africa	Temperature. Average temperature is between 37-45°C	Higher outbreaks at the periods of high temperature	Northern Nigeria	Mohammed et.al., (2000)
			Zaire	Cheesbrough et.al., (1995)
			Benin	Besancenot et. al., (1997)
			Burkina Faso, Niger and Mali	Thomson et.al., (2006)
			Niger	Jackou-Boulama et.al., (2005)
			Africa	Ceuvas et.al., (2008)
			Africa (Review)	Schwartz et.al., (1989)
			Africa (Review)	Teyssou and Rouzic, (2007)
			Burkina Faso and Niger	Yaka et.al., (2008)

Europe			West England	Stanwell-smith et al., (1994)
Africa	Relative Humidity Average was 30.2%	Outbreaks were observed when the Relative humidity is low.	Nigeria	Mohammed et.al., (2000)
			Region	Molesworth et.al. (2003)
			Region	Tzeng and Stephens (2000)
			Region	Ceuvas et.al., (2008)
			Mali	Thomson et.al., (2006)
			Africa (Review)	Teyssou and Rouzic, (2007)
			Burkina Faso and Niger	Yaka et.al., (2008)
			Mali	Sultan et.al., (2005)
Europe			Moscow	Achtman et.al., (2001)
Asia			China	Hu, (1990)

Region	**Factor**	**Outcome**	**Country**	**References**
India			India	Bhatia, (1968)
Africa	Rainfall	At the onset of rain, the spread of the disease stops.	Northern Nigeria	Mohammed et.al., (2000)
			Burkina Faso and Niger	Yaka et.al., (2008)
Middle East			Tehran, Iran	Mosavi-Jarrahi et. Al., (2009)
World			Global (Review)	Schwartz et.al., (1989)

Table 6 shows other studies that were conducted in different parts of the world which suggest that there is a significant relationship between climate and meningococcal meningitis. The majority of the studies conducted to ascertain the relationship of meningococcal meningitis disease and climate were mostly in the African continent which indicates that the climate in Africa is a major factor to the spread of the disease.

Other Factors

Urbanization Level

As living in the cities has gradually become the norms in most low and middle income countries which has eventually resulted into a rapid urbanization coupled with the poor economic conditions of the countries. The resultant effect of rapid urbanization in cities has brought about many urban health challenges which are directly as a result of the inadequate facilities and services that are provided by the government to cater for the ever growing population. Diseases like Malaria, Cholera, diarrheal and typhoid fever has a direct link with urbanisation and lack of adequate sanitary facilities.

Studies have indirectly shown that urbanization has a relationship with the spread of meningococcal meningitis disease. Most of the studies carried out on meningococcal disease were mainly in the urban areas, indicating that the disease is more common in the urban centres [51 66].

Recreational Spaces

The contribution to health on outdoor recreation is not only from the perspective of “wellness”. Health, according to WHO [13] was defined as a “state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Outdoor recreation affects all those facets of health and helps the physical and emotional well being. One major advantage of being outdoors is that staying indoors subjects an individual to much dangers due to the fact that pollution exposures in homes and offices is always more than outdoors [68]. Meningococcal meningitis being an airborne disease will spread faster when people are confined in an indoor environment.

Table 7 shows the summaries of the factors and sub factors that influences the spread of meningococcal meningitis disease in different regions of the world. It shows that each region has a peculiar factors and sub factors that is significant to it.

Table 7: Summaries of factors and sub factors influencing the spread

S/N	Factors	Sub factors	Regions				
			Africa	America	Asia	Europe	M/east
1.	Socioeconomic Status	Poor Housing Conditions	Significant	Significant	Significant	Significant	
		Education and Income level	Significant	Significant	Significant	Significant	
2.	Demography	Age	Significant	Significant			Significant
		Sex	Significant				
3.	Social Behaviour	Smoking		Significant	Significant	Significant	
		Clubbing and Bar		Significant			
4.	Respiratory tract/ viral infections	Influenza	Significant	Significant		Significant	
		Viral infections	Significant	Significant		Significant	
5.	Climatic Conditions	Geographical location	Significant				
		Environment	Significant				
		Relative humidity	Significant				
		Temperature	Significant				
		Rainfall	Significant				
6.	Urbanization	Crowded environment	Significant		Significant	Significant	

		Inadequate facilities	Significant				
7.	Recreational spaces	Parks and Gardens	Significant				

Table 8: Model for the Risk factors of Meningococcal meningitis

Meningococcal Meningitis Disease		
Factor	**Sub Factor**	**Indicator**
Climatic and geographical Localization	Region (Africa Meningitis Belt)	1. Latitudes 0° and 10° north. 2. Latitudes 2° and 13° north. 3. Latitudes 4° and 16° north 4. Latitudes 8° and 19° north.
	Rainfall Isohyets	1. High 2. Medium 3. Low
Climate and Environment	Temperature	1. High 2. Medium 3. Low
	Relative Humidity	a. High b. Medium c. Low
	Rainfall	1. High 2. Medium 3. Low

Socioeconomic Factors	Housing Condition	1. Open space 2. Adequate windows 3. Windows size

Meningococcal Meningitis Disease continued

Factor	Sub Factor	Indicator
Socioeconomic Factors	Overcrowding	a. Population density b. Population per house c. Single room occupancy d. Households in a house
	Educational Level	1. Illiterate 2. Primary school 3. Secondary school 4. Tertiary education
	Income Level	1. High 2. Medium 3. Low
	Deprived Areas	1. Lack of drainages 2. Lack of refuse disposal points 3. Inadequate power supply 4. Lack of recreational spaces 5. Inadequate health centres

Respiratory Track Disease	Influenza	1. Had influenza before the outbreaks of the disease 2. Having influenza during the disease outbreaks
	Viral Infection	a. Had a viral infection shortly before the outbreaks of the disease b. Having viral infection during the disease outbreaks
Demography	Sex	a. Male b. Female
	Age	1. 0-5 2. 5-15 3. 15-20 4. 20 and above

Meningococcal meningitis Disease Continued

Factor	**Sub Factor**	**Indicator**
Social Behaviours	Smoking	1. Excessive smoking 2. Moderate 3. Once in a while 4. Children that are exposed to the smoke of cigarette
	Clubbing	a. Bars without good ventilation. b. Crowded dancing halls
	Large Gatherings	1. Inadequate venues for large gathering 2. Small capacity halls 3. Improper ventilation in halls
Other Factors	Sub Factor	Indicator
Urbanization Level	Population density in relation to available facilities	1. High 2. Medium 3. Low

Recreational spaces	Open recreational spaces	1. Functional recreational space 2. Capacity
	Halls for recreational activities	a. Functional halls b. Large capacity

Table 8 shows a model for the risk factors, sub factors and indicators for the spread of meningococcal meningitis disease.

Conclusion

The paper described the various factors that have influenced the occurrence of the disease in different regions of the world. Journal articles that are related to the risk factors for meningococcal disease were reviewed. The paper has clearly identified the most important factors like Poor Housing Condition and Household overcrowding, Education and Income Level, Age, Sex, Smoking, Clubbing and Bar, Respiratory Tract/Viral Infections, Climatic and Geographical Location, Environment, Relative Humidity and Temperature, Rainfall, Level of Urbanization and Recreational Spaces as the cause of the spread of meningococcal meningitis.

Meningococcal meningitis disease does not just occur without any of the factors that have been discussed above not in place. In spite of the different natural characteristics of the regions of the world there are some common factors that determine the occurrence of the disease. African meningitis belt that has a peculiar geographical characteristic stands out as the area that is most plagued by the disease. The risk factors that have been discussed above must not all be in place before the occurrence of the disease, that is why the level of outbreaks in other regions except Africa is low compared to Africa's meningitis belt where there are frequent and large epidemics of the disease. It is likely because all the risk factors for the meningococcal disease are fully in existence in the African meningitis belt.

Understanding clearly how these factors influence in the occurrence of the disease will help the authorities in prevention strategy that it will employ.

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