TITLE OF STUDY:

Epidemiology of Keratoconus and Associated Risk Factors in High School Students in Couva, Trinidad

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Abstract

Aim: To determine the prevalence of keratoconus and associated risk factors of keratoconus among high school students in Couva.

Method: This study was a descriptive, cross-sectional study on the prevalence of keratoconus among high school students in Couva. Schools were selected based on their proximity to the University of the West Indies Optometry Clinic in Cova. Systematic random sampling technique was used to select students to participate in the study. A structured questionnaire was used to collect data and assess risk factors of keratoconus. Clinical assessment including visual acuity, scissors reflex, and topography was performed for those at risk of keratoconus. The data was exported to Statistical Package for Social Sciences (SPSS) where descriptive analysis tests were done, and logistic regression analysis was used to determine associated risk factors. $p<0.05$ was considered statistically significant.

Results: The prevalence of keratoconus was 0.46% (2/432) and 47.7% of the participants were at risk of having keratoconus. Family history was found to be significantly associated with keratoconus (OR = 142.333, 95% CI: 7.119–2845.711; p=0.00). The awareness of keratoconus was low among the study population (9.0%).

Conclusion: This prevalence of keratoconus and those at risk of having keratoconus among high school students in Couva was significantly high when compared with global findings. Family history was the most significant factor of keratoconus and there was a poor awareness of

keratoconus. Awareness about keratoconus among high school children in Trinidad is highly advised for early detection of keratoconus and those at risk.

Introduction

Keratoconus is an ocular condition involving the cornea eye's cornea. The cornea is a transparent, outer layer of the eye that has functions such as focusing light rays onto the retina and providing protection for some internal structures of the eye. The cornea normally assumes a dome-like shape which allows light to sharply focus onto the retina with minimal scattering.[1] However, in persons with keratoconus, the cornea protrudes in an irregular cone-like shape. This conical shape induces irregular astigmatism and light rays are scattered upon reaching the retina. This results in blurry and distorted vision in persons with keratoconus.[2]

Keratoconus is usually a bilateral disease but can be asymmetric in nature. It is a non-inflammatory ectasia that is progressive and will eventually lead to the thinning and steepening of the cornea.[2] It is one of the main causes of vision impairment in adolescents and can cause forms of social impairment if left untreated.[3]

The cause of keratoconus is unknown. However, there are risk factors which make individuals more susceptible to developing the disease. For example, research on keratoconus showed that environmental and ethnic factors may have a part to play in the development of keratoconus.[2] Multiple studies have shown that age, ethnicity, eye rubbing, family history and parental consanguinity are major risk factors for keratoconus.[3]

One study done on the epidemiology of keratoconus in various regions in Asia, which compared persons of Asian descent with white persons, found that Asians are more prone to developing keratoconus.[4] Trinidad has a large Asian population, therefore, one could assume that

keratoconus may be prevalent in the population. Additionally, another study conducted in a university hospital in France, concluded that eye rubbing is a major risk factor for developing the disease.[2] This may be another indication that keratoconus is prevalent in Trinidad since eye rubbing may be a consequence of our hot and dusty climate. In a different study conducted on secondary school students in Cameroon, eye rubbing was the most significant risk factor for keratoconus, followed by refractive error, allergic diseases, and sunlight exposure.[3]

There is a need for further exploration of these risk factors and their association with keratoconus especially in Trinidad, as no studies have been conducted locally on this topic. Keratoconus screening is crucial for early detection and management to avoid the burden of visual impairment. Therefore, the study aims to determine the prevalence of keratoconus and associated risk factors among high school students in Trinidad.

Relevance to Public Health

Keratoconus begins to develop at puberty and continues to progress until around the age of 25. The treatment for keratoconus is corneal cross-linking surgery. In this procedure, ultraviolet rays and riboflavin are used to strengthen the bonds between the fibers of the cornea.[5] This prevents the cornea from continuing to thin and steepen. However, this surgery does not completely stop the progression and is most effective when done in the early stages.[6]

Due to keratoconus being the most treatable in its early stages, education, awareness and screening is extremely important. Few school-based studies have been conducted on keratoconus and most of these studies were done outside the Caribbean. There is a need to conduct this study to know how many children have this problem, and those at risk of having this condition. This will help in developing strategies for preventing visual impairment. This study is therefore aimed to determine the prevalence of keratoconus among high school children in Trinidad, where the findings will be compared with global findings.

Through this study, students can be informed whether they have keratoconus or are at risk of developing keratoconus. This is beneficial to the participants as they can know their status and can be advised on management options. This study can also bring awareness about keratoconus to the community. The data collected is beneficial to the public health sector as it aids in increasing the medical treatment and management of keratoconus.

Literature Review

1. *Prevalence of keratoconus*

Globally:

Between the years 1959 to 2021, the global prevalence of keratoconus varied between 0.2% and 4,790 per 100,000 persons.[7] Studies done in various countries worldwide found varying prevalence of keratoconus. In Norway, it was calculated that 192.1 persons per 100,000 persons in the public were keratoconic.[8] However, in New Zealand, it was found that every 1 in 191 (0.52%) high school students were keratoconic.[9] Research done on the epidemiology of keratoconus in varies countries such as USA, France, Israel, India and Saudi Arabia revealed that the prevalence of keratoconus can vary from place to place but can have a prevalence as high as 5% in places such as the Middle East.[10]

Regionally:

There are very few studies that have been done on keratoconus in the Caribbean region. A study was done in French Caribbean Isles comparing the corneal thickness and curvature in myopic and keratoconic eyes of patients from French Caribbean Isles (FCI) and France. Both regional and global data were contrasted to establish that patients from FCI were diagnosed at a later age and had thinner corneas when compared to patients from France.[11] Although the study has data based on the Caribbean, there were no studies which correspond to the prevalence of keratoconus in the Caribbean region.

Locally:

There are no published studies on keratoconus in Trinidad. Hence it is important to conduct research on the epidemiology of keratoconus in Trinidad to determine the prevalence. This study's findings can help to inform and raise awareness for both experts and the public.

2. *Demographic distribution of keratoconus*

- Age

Keratoconus has its most significant incidence in the age of 20 and 30 years, and progression occurs up to 35 years of age.[10] This is similar to findings of another study aimed at determining the epidemiology of keratoconus worldwide by gathering data from countries such as USA, Japan and India, where eyes with severe keratoconus presented at a younger average age, (18.8 ± 5.35 years) than moderate keratoconus (23.69 ± 8.07 years).[12] It can be inferred that keratoconus can present itself in persons ranging from teens to late twenties. This is again seen in a different study done on the epidemiology of keratoconus in Mexican adolescents, as the mean age at diagnosis was 16.1 years.[13] Similar findings were found in New Zealand, where the mean age keratoconus individuals was found to be 14.9 year.[9]

- Sex

The prevalence and severity of keratoconus cannot be generally categorized through the distribution of sex since depending on other factors, the dominating sex varies for keratoconus. In a study done in Jordan University Hospital, it was found that 72.3% of males' eyes and 71.8% of females' eyes had severe keratoconus; 17.3% of males' and 28.2% of females' eyes had moderate

keratoconus; and 10.4% of males' eyes had mild keratoconus, which was not recorded in females.[14] The sex distribution varied with the severity of keratoconus. In a different study done on the prevalence and risk factors of keratoconus worldwide, the keratoconus prevalence was 20.6 per 1000 in men and 18.33 per 1000 in women.[15] On the other hand, in a study done in Mexican adolescents, the prevalence of keratoconus was distributed as 66.6% in females and 33.3% in males.[13] Therefore, the findings of sex and its association with keratoconus varies across studies. Hence, based on multiple factors, a dominant keratoconic sex cannot be ascertained.

- Ethnicity

Keratoconus was recorded to be associated with ethnicity. Investigations on the influence of ethnic origin on the incidence of keratoconus in Asians and white patients done in Dewsbury District General Hospital in the UK, found that the incidence of keratoconus was significantly higher in the Asian participants (1 in 4000) than in the white participants (1 in 30000). The study also concluded that Asians tend to present with keratoconus at a younger age when compared to white participants.[16] Similar findings were also discovered in another study done in the UK, in the ophthalmology department of a Midlands hospital, which aimed at detecting if ethnic origin influences the incidence or severity of keratoconus. This study also found that the incidence of keratoconus in Asians is higher compared to whites, the age of onset in Asians is also younger, and Asians also tend to require corneal graft at a younger age.[17] Hence it can be understood that not only the prevalence of keratoconus is influenced by ethnicity, but also the severity and age of onset of keratoconus can be affected by ethnicity.

- Environment/Geographic Location

Climate can affect keratoconus as areas with considerable sunshine and hot weather have a higher prevalence of keratoconus compared to locations with cooler climates and less sunshine.[18] In Russia, where there is less sunshine, the prevalence of keratoconus was 0.3 per 100,000 whilst in Central India, where there is lots of sunshine, the prevalence of keratoconus was 2300 per 100,000.[18] This shows that the prevalence of keratoconus can be influenced by the type of climate there is in an area. This can also be seen in other instances as a higher prevalence of keratoconus has been identified in Saudi Arabia, Iran, New Zealand, Israel, and some Pacific Islands due to high ultraviolet exposure.[12]

3. Risk Factors

- Parental Consanguinity

Consanguinity is the kinship of two individuals characterized by the sharing of common ancestor(s).[19] A study done in 2010 estimated that the global prevalence of parental consanguinity population is 10.4%.[20] Research done at the University of Lahore Teaching Hospital concluded that a relationship between consanguinity and keratoconus was obtained with significant results.[21] Parental consanguinity allows for an increased probability of genetic diseases/complications to pass down. Although there are resources which contain consanguinity as a risk factor of keratoconus, there are varying opinions of it being a true risk factor. There are few studies that reported this factor.

- Atopic diseases

Atopy is an inherited condition that makes individuals more likely to have a familiar group of diseases.[22] The University of Ottawa Eye Institute conducted a study which showed that the incidence of atopy was 35% in keratoconus cases as opposed to the control group, where the incidence was only 12%.[23] In a study done in South Korea, the findings revealed statistically significant associations between atopic diseases and keratoconus as well.[24] Some atopic diseases which are considered risk factors for keratoconus are asthma and hay fever.[25]

- Eye Rubbing

Eye rubbing is an action that can cause injury due to the frequency being performed and/or the force being applied. The mechanical force of eye rubbing can affect a patient's cornea leading to the development of keratoconus.[26] It was found that 65.6% of keratoconus patients in a study conducted in an optometric contact lens practice had a history of eye rubbing.[27] In another study done on the correlation between keratoconus and eye-rubbing in the University of Jazan, it was found that in 83% of keratoconus patients rub their eyes frequently whereas in healthy age-matched eyes, 58% of them rubbed their eyes.[28] Other studies such as one done on the risk factors of keratoconus among secondary school students in Cameroon found that eye rubbing was recorded as the most significant risk factor for keratoconus.[3]

- Food

There is little to no research done to conclude that certain foods affect keratoconus. However, certain food allergies can lead to itching of the eye. Additionally, there is some research that

suggests that certain deficiencies in nutrients and metabolites can be linked to keratoconus.[29] However, this has not been studied enough to directly link specific foods to keratoconus.

4. *Awareness of keratoconus*

Research done in Saudi Arabia found that the awareness of keratoconus reported in the public was moderately poor, with most people not knowing the treatment methods nor consequences of untreated keratoconus.[30] In another study done on the awareness of keratoconus in Jeddah, the conclusion was that there was a deficient awareness about keratoconus, and health education programs to raise the public awareness about keratoconus was recommended.[31] There are no studies done regionally or locally on the awareness of keratoconus however, it is important to promote the awareness among the population in Trinidad so that persons can participate in screenings for keratoconus.

Aim of Study

The purpose of this study is to determine the prevalence of keratoconus among high school students in Couva, as well as those at risk of developing keratoconus.

Objectives of Study

- To ascertain the prevalence, demographic distribution and clinical presentations of keratoconus among high school students in Couva, Trinidad
- To assess the possible risks and associated factors of keratoconus among them
- To determine the awareness of keratoconus among them

Research Questions

- What is the prevalence, demographic distribution and clinical presentations of keratoconus among high school students in Couva, Trinidad?
- What are the possible risks and associated factors of keratoconus among them?
- What is the awareness of keratoconus among them?

Ethical Considerations

- Ethical Approval was obtained from the University of the West Indies Research and Ethics Committee to carry out the study.
- Permission was obtained from the Ministry of Education to conduct the study in schools.
- Permission from the principals of selected schools was also obtained.
- Consent was obtained from the parents and students to participate in the study.

Method

Study Setting:

The study was conducted in Trinidad and Tobago (T&T). T&T is a dual-country located in the tropical zone with an overall population of 1,409,398 persons.[32] Due to its zonal location Trinidad has hot weather. The island of Trinidad has an area of about 4800 square km,[33] and is generally separated into 3 major regions: South, Central and North.

The ethnic composition of the nation is roughly 34.2% African, 35.4% East Indian, 22.8% mixed and 7.6% being other races.[34] There are approximately 199 secondary schools in T&T which are scattered throughout the country, and six of these secondary schools are in Couva. The average age range of students in high schools in Trinidad is 12-16 years from forms 1-5.[35] The secondary schools in T&T are grouped according to 3 main categories: government funded, partially government funded and private schools. Government funded schools are multi-religious institutions and mixed-gender schools.

There is an enrollment rate of approximately 93.204% of adolescents in secondary schools.[36] Thus, there was adequate access to students to participate in this study.

This study was conducted in secondary schools which are in Couva. Couva is a town located in west-central Trinidad. It has a population of approximately 48858 persons which was taken from the 2011 census.[37] The Couva Hospital and Multi Training facility is a popular landmark located in Couva and it is where the UWI Optometry Clinic is situated. There are six secondary schools which are in Couva, all of which are near the Couva Medical and Multi-Training Facility.

Study Design:

The study was a descriptive cross-sectional, school-based study.

Study Population:

High school students in Couva made up the study population.

Study Sample:

The sample size was calculated using the single population proportion formula:

$$n = \frac{N \times X}{(X + N - 1)}$$

where

$$X = \frac{(Z_{\frac{\propto}{2}})^2 \times p \times (1 - p)}{(MOE)^2}$$

n =sample size

N= population size

Z= critical value of the normal distribution at

p= sample proportion (the average prevalence of keratoconus taken from recent studies)

MOE= margin of error

A confidence level of 95% was used and a value of $p<0.05$ was considered significant for this study.

Since a 95% confidence level was used, the value of the Z statistic at this confidence level is 1.96.

Additionally, a margin of error of 0.5% was used.

The population size was assumed to be 100,000.

The value of p was calculated to be 0.29%. This value was calculated by taking the average prevalence of keratoconus from 3 different studies. In a study done in New Zealand, the average prevalence of keratoconus was 0.52%,[9] in a study done in Norway, it was 0.19%,[8] and in a study done in the USA, it was 0.16%.[38] Therefore, the average of all these values is 0.29% which is what was used as the proportion of high school students with keratoconus. Using the formula, the sample size was calculated to be 443 but only 432 students gave consent to participate in the study therefore, 432 questionnaires were collected, and a 97.5% response rate was obtained.

Inclusion Criteria:

High school students in Couva whose consent to participate in the study were obtained were included in the study.

Exclusion Criteria:

High school students who had corneal pathologies, trauma to the cornea or any condition of the cornea unrelated to keratoconus.

Sampling Technique:

The study sample was taken from three different secondary schools in Couva. Convenience sampling was used to decide that high school students in Couva would be investigated due to the proximity of these schools to the Couva Medical and Multi Training Facility. These schools were selected because they are mixed-gender schools and multi-religious institutions. In other words, only government funded schools were considered in this study.

First step: Convenience sampling was used to select 3 schools located in Couva which meet the criteria of being government institutions and being near to the Couva Medical and Multi Training Facility. The sample size was divided by 3 to determine how many students would be screened in each school. Thus, 148 students were selected from each school. Since there are also 5 forms in each school, 30 students were selected from each form.

Second Stage: The names of all the students in each form were gathered from a list provided by the form mistress/master. Their names were coded and inserted into a software called Picker Wheel. This software allows for the use of simple random sampling to select each student. The wheel was spun 30 times to select 30 students from the form. This was done for each form in each school to get all 443 participants needed for the study. After, 443 participants were selected, and the consent forms were given out, 432 viable questionnaires were returned.

Data Collection procedure:

1. Ethical approval was obtained from the UWI Ethics Committee.
2. Permission from the MOE to attend the various schools to collect data was obtained.
3. Permission from the schools' Principals was obtained.
4. The schools were visited, and consent forms were given out to the students to obtain permission from their parents and the students themselves.
5. Once permission was granted, students filled out the keratoconus risks assessment questionnaire to screen for those who might be at risk for having keratoconus.
6. The visual acuity (VA) of the students were taken. This was done by placing the EDTRS chart 4 meters away from a seated patient. An occluder was used to cover the patient's

left eye and the patient was instructed to use their right eye to read the smallest set of letters they could see on the chart. This process was then repeated while the patient's right eye was occluded. Finally, the patient was asked to do the same thing with both of his/her eyes open. This process was repeated to take the patient's near VA as well using the EDTRS near chart.

7. The handheld autorefractor was used to determine the refractive status. The patient was asked to align their eyes with the eyepiece of the machine. The device automatically took the patient's refractive error using wavefront technology.
8. The retinoscope was used to determine if there was a scissor reflex when scanning their cornea. The examiner stood about an arm's length away from the patient and briefly passed the light over the patient's eye a few times.
9. Students who were suspected to be keratoconic were referred to the Couva Medical and Multi-Training Facility to be screened using the topographer. This confirmed if they had keratoconus or not. The patient was required to place their chin on a chin rest and their forehead against a forehead bar. The patient had to look straight ahead into the machine while the machine took the measurements.

Data Protection:

Participants confidentiality was protected by using non-identifiable codes to store each participants information. Additionally, people not involved in the research project did not have access to the data as it was stored on password protected computers.

Outcome Variables:

Presence of refractive error, eye rubbing (rated a 3/5 or more), parental consanguinity, family history of keratoconus, presence of atopic disease(s), sunlight exposure (more than 8 hours per week), near work (more than 24 hours per week) and changing spectacles at least once a year were considered as risk factors of keratoconus based on literature review. All of the participants had diet as risk factor. Individuals with at least 3 of the risk factors (excluding diet) were considered to be at risk of developing keratoconus.

Operational definitions:

Awareness of keratoconus:

Defined as having heard of keratoconus before or knowing that the condition exists.

Refractive error:

Having a VA of less than or equal to 6/12 on at least one eye that can be improved with glasses.

Eye Rubbing:

Defined as rubbing the eye with the knuckle of the hand vigorously rated 3/5 or more.

Parental Consanguinity:

Defined as having both parents either as first cousins, second cousins or distant relatives.

Sunlight Exposure:

Exposure to sunlight for at least 8 hours per week.

Near Work:

Doing more than 24 hours of near work per week such as reading, cellphone use and computer work.

Family History:

Having a relative who has been previously diagnosed with keratoconus.

Presence of Atopy:

Defined as having one or more of the following diseases: eczema, asthma, hay fever, food allergies, pollen/dust allergies, animal fur allergies and vernal keratoconjuncitivits.

Diet:

Defined as eating one or more of the following foods at least twice per week: fish/chicken, red meat, eggs, milk, beans, rice/pap/pasta/bread, vegetables and fruit.

Data Analysis:

The data was entered into Microsoft Excel and then exported to the Statistical Package for Social Sciences (SPSS) where descriptive analysis tests such as frequency, mean and standard deviation were calculated. Logistic regression was used to determine associated risk factors, where a $p<0.05$ was considered statistically significant.

Results

Demographic profile of study participants:

A total of 432 students aged 12-17 years with a mean age of 14.08 (± 1.49) years participated in the study giving a 97.5% response rate. Majority were of East Indian descent (48.1%), females (52.1%), 14 years old (23.1%) and in form 2 (25.5%) (Table 1).

Table 1.0: Demographic profile of participants

Variable	Frequency (N=432)	Percentage (N=100%)
Gender		
Female	225	52.1
Male	207	47.9
Age		
12	72	16.7
13	97	22.5
14	100	23.1
15	79	18.3
16	53	12.3
17	31	7.2
Ethnicity		
East Indian	208	48.1
African	96	22.2
Chinese	11	2.5
Mixed	117	27.1
Form Class		
1	107	24.8
2	110	25.5
3	85	19.7
4	67	15.5
5	63	14.6

Clinical profile of study participants:

Most of the participants had an unaided and aided visual acuity (VA) of 0.4 LogMAR (6/15 Snellen) or better and 0.03 LogMAR (approximately 6/6 Snellen) on both eyes respectively. The prevalence of refractive error was 32.9% and myopia was the most prevalent refractive error followed by astigmatism (25.4%). The most prevalent risk factors for keratoconus among the participants was eye rubbing (70.6%) followed by more than 8 hours of sunlight exposure per week (51.4%), and having atopic disease(s) (48.4%). (Table 2)

Table 2.0: Clinical profile of participants

Variables	Frequency (N=432)	Percentage (N=100%)
Visual Acuity		
Right Eye Unaided VA		
Better than 6/12	376	87.0
6/12 or worse	56	13.0
Left Eye Unaided VA		
Better than 6/12	384	88.9
6/12 or worse	48	11.1
Both Eyes Unaided VA		
Better than 6/12	386	89.3
6/12 or worse	46	10.7
Risk factors		
Refractive Error		
Yes	142	32.9
No	290	67.1
Eye Rubbing ≥ 3/5		
Yes	305	70.6
No	127	29.4
Family History of Keratoconus		
Yes	4	0.9
No	428	99.1
Parental Consanguinity		
Yes	43	10
No	389	90
Presence of Atopic Diseases		
Yes	209	48.4
No	223	51.6
≥ 8 hours Sunlight Exposure per week		
Yes	222	51.4
No	210	48.6
≥ 24 hours near work per week		

Yes	121	28.0
No	311	72.0
Diet		
Fish/Chicken		
Yes	352	81.5
No	80	18.5
Red Meat		
Yes	70	16.2
No	362	83.8
Eggs		
Yes	225	52.1
No	207	47.9
Beans		
Yes	146	33.8
No	286	66.2
Milk		
Yes	220	50.9
No	212	49.1
Rice/Pap/Pasta/Bread		
Yes	379	87.7
No	53	12.3
Vegetables		
Yes	291	67.4
No	141	32.6
Fruit		
Yes	274	63.4
No	158	36.6
Frequency of Changing Spectacles		
Never changed/No spectacles	292	67.6
Once a year or more	45	10.4
Every 2 years or less	95	22.0

Objective 1: To ascertain the prevalence, demographic distribution and clinical presentations of keratoconus among high school students in Couva, Trinidad

The prevalence of keratoconus was 0.46 % (2/432). The keratoconic individuals were East Indian (50%), mixed (50%), and aged 14 (50%) to 17 (50%) years with a mean (±SD) age of 15.5 (±2.12) years. Additionally, the keratoconic participants were female (50%) and male (50%). Their mean unaided VA was 1.33 LogMAR (approximately 6/120 Snellen) on both eyes and mean aided VA was 0.35 LogMAR (approximately 6/12 Snellen) on both eyes. The range of their refractive error was between −1.50 to −6.25DS of myopia, with astigmatism ranging between −3.50 to −7.50DC. Their Kmax mean was 56.15 dioptres. (Table 3). The individuals with keratoconus also displayed many risk factors of keratoconus themselves with 100% having refractive error, eye rubbing more than 3/5, and atopic diseases (Table 4).

Table 3.0: Clinical presentation of keratoconus

	Min	**Max**	**Mean**	**STD**
OD unaided VA (LogMAR)	1.32	1.34	1.33	0.01
OS unaided VA (LogMAR)	1.32	1.34	1.33	0.01
OU unaided VA (LogMAR)	1.30	1.32	1.31	0.01
OD aided VA (LogMAR)	0.40	0.42	0.41	0.01
OS aided VA (LogMAR)	0.32	0.34	0.33	0.01
OU aided VA (LogMAR)	0.32	0.38	0.35	0.04
Sphere (DS)	-1.50	-6.50	-4.44	2.21
Cylinder (DC)	-3.50	-7.50	-5.19	1.82
Kmax (D)	50.18	66.5	56.15	6.66
Age	14	17	15.50	2.12

Table 4.0: Clinical profile of those with keratoconus

	With Keratoconus	**Without Keratoconus**	**Total= 432**
Refractive Error			
Yes	2 (0.5%)	140 (32.4%)	142 (32.9%)
No	0 (0.0%)	290 (67.1%)	290 (67.1%)
Eye Rubbing ≥ 3/5			
Yes	2 (0.5%)	303 (70.1%)	305 (70.6%)
No	0 (0.0%)	127 (29.4%)	127 (29.4%)
Family History			
Yes	1 (0.2%)	3 (0.7%)	4 (0.9%)
No	1 (0.2%)	427 (98.8%)	428 (99.1%)
Atopic Disease(s)			
Yes	2 (0.5%)	207 (47.9%)	209 (48.4%)
No	0 (0.0%)	223 (51.6%)	223 (51.6%)
≥ 8 hours sunlight exposure per week			
Yes	1 (0.2%)	221 (51.2%)	222 (51.4%)
No	1 (0.2%)	209 (48.4%)	210 (48.6%)
≥ 24 hours of near work per week			
Yes	0 (0.0%)	121 (28.0%)	121 (28.0%)
No	2 (0.5%)	309 (71.5%)	311 (72.0%)
Frequency changing spectacles			
Once a year or more	1 (0.2%)	44 (10.2%)	45 (10.4%)
Less than once a year/ No spectacles	1 (0.2%)	386 (89.4%)	387 (89.6%)
Parental Consanguinity			
Yes	0 (0.0%)	43 (10.0%)	43 (10.0%)
No	2 (0.5%)	387 (89.6%)	389 (90.0%)

Objective 2: To assess the possible risks and associated factors of keratoconus among high school students in Couva, Trinidad

Possible Risk Factors:

A total of 206 (47.1%) participants were considered to be at risk of developing keratoconus as they possessed 3 or more of the risk factors. Among those that were at risk for keratoconus, the most prevalent risk factor was eye rubbing (87.4%), followed by more than 8 hours exposure to sunlight per week (71.8%), and atopy (68.4%). The majority of those at risk were female (54.4%), 15 years old (21.4%) and East Indian (47.6%). (Table 5)

Table 5.0: Demographic and clinical profile of those at risk for keratoconus

Variable	Frequency (N=206)	Percentage (N=100%)
Gender		
Female	112	54.4
Male	94	45.6
Age		
12	39	18.9
13	42	20.4
14	38	18.4
15	44	21.4
16	28	13.6
17	15	7.3
Ethnicity		
East Indian	98	47.6
African	45	21.8
Chinese	6	2.9
Mixed	57	27.7
Refractive Error		
Yes	106	51.5
No	100	48.5
Eye Rubbing $\geq$ 3/5		
Yes	180	87.4
No	26	12.6
Family History of Keratoconus		
Yes	3	1.5
No	203	98.5
Parental Consanguinity		
Yes	29	14.1

No	177	85.9
Presence of Atopic Diseases		
Yes	141	68.4
No	65	31.6
≥ 8 hours sunlight exposure per week		
Yes	148	71.8
No	58	28.2
≥ 24 hours near work per week		
Yes	95	46.1
No	111	53.9
Frequency of Changing Spectacles		
Once a year or more	43	20.9
Less than once a year/ No spectacles	163	79.1

Associated Factors:

A statistically significant relationship between keratoconus and family history was found among those with keratoconus using logistic regression (OR = 142.333, 95% CI: 7.119-2845.711; p=0.001). No associations were found between refractive error (p=0.994), eye rubbing (p=0.998), parental consanguinity (p=0.998), atopic diseases (p=0.995), changing spectacles once a year or more (p=0.127), more than 24 hours of near work per week (p=0.996) or more than 8 hours of sunlight exposure per week (p=0.969) and keratoconus in those with the condition.

In those at risk of developing keratoconus, no associations were found among the participants and their gender (p=0.364), their ethnicity (p=0.739) or their age (p=0.663) and being at risk. (Table 6)

Table 6.0: Associated risk factors for keratoconus

Variable	OR (95% CI)	p-value	Statistically Significant?
Associated risk factors in those with keratoconus			
Family History	142.333 (7.119–2845.711)	0.001	Yes
Sunlight Exposure	0.946 (0.059- 15.217)	0.969	No
Changing Spectacles	8.773 (0.539- 142.729)	0.127	No
Near Work	-	0.996	No
Eye Rubbing	-	0.998	No
Parental Consanguinity	-	0.998	No
Atopic Diseases	-	0.995	No
Refractive Error	-	0.994	No
Associated demographics in those at risk for keratoconus			
Age	1.031 (0.908-1.171)	0.663	No
Gender	0.839 (0.575-1.225)	0.364	No
Ethnicity	1.026 (0.883-1.192)	0.739	No

Objective 3: To determine the awareness of keratoconus in high school students in Couva, Trinidad

Of the 432 participants assessed, only 39 (9.0%) were aware of keratoconus. Majority were female (56.4%), East Indians (53.9%), 14 years old (35.9%) and in form 2 (53.9%) (Table 7).

Table 7.0: Demographic distribution of participants that are aware of keratoconus

Variable	Frequency (N=39)	Percentage (100%)
Gender		
Male	17	43.6
Female	22	56.4
Ethnicity		
East Indian	21	53.9
African	6	15.4
Mixed	10	25.6
Chinese	2	5.1
Age		
12	3	7.7
13	12	30.8
14	14	35.9
15	5	12.8
16	2	5.1
17	3	7.7
Form Class		
1	3	7.7
2	21	53.9
3	9	23.1
4	1	2.5
5	5	12.8

Discussion

Prevalence, demographic distribution and clinical presentations of keratoconus among high school students in Couva, Trinidad

Prevalence:

The prevalence of keratoconus was found to be 0.46% (2/432). This finding is similar the prevalence of keratoconus in high school students in New Zealand, where keratoconus was present in 1 in every 191 high school students (0.52%).[9] However, the study in New Zealand was conducted on a larger sample size than the one used in this study therefore, this could be a reason why the prevalence in New Zealand was slightly higher. On the other hand, the prevalence of 0.46% was higher compared to the prevalence of keratoconus in Norway, which was 0.19%.[8] This difference could be because the study in Norway targeted the general population, whereas this study focused on persons of the adolescent age, which is where the majority of keratoconic patients tend to develop the condition.

Demographic Distribution:

A generalized demographic distribution cannot be described for the study population as only 2 individuals with keratoconus were found. However, among these 2 individuals, one was male, and one was female therefore, a dominant keratoconic sex could not be determined. However, varied findings were reported in other studies, and keratoconus has not been proven to be more prevalent in one sex than the other. For example, the prevalence of keratoconus was 20.6 per 1000 in men and 18.33 per 1000 in women in a study in Iran,[15] and on the other hand, the prevalence of keratoconus was distributed as 66.6% in females and 33.3% in males in a different study in Mexico.[13]

Additionally, one keratoconic patient was 14 years old, while the other was 17 years old, giving a mean age of 15.5 years. This finding is similar to another study done on Mexican adolescents where the mean age of keratoconus diagnosis was 16.1 years,[13] and also similar to findings in New Zealand where the mean age of those with keratoconus was found to be 14.9 years.[9]

The incidence of keratoconus seems to be much higher in persons of Asian descent when compared to other ethnicities.[16] In this study, one keratoconus patient was of East Indian descent, while the other was a mix of East Indian and African. Therefore, both keratoconus patients did come from Asian ethnic backgrounds. Therefore, this finding is in keeping with findings from other studies where the common finding is that the Asian ethnicity tends to be more susceptible to developing keratoconus.

Clinical Presentation:

In terms of the clinical presentation of keratoconus the mean Kmax for those with keratoconus was 56.15 dioptres and the mean best corrected distance VA was 0.35 LogMAR. This can be compared with the study done on keratoconus in New Zealand, which showed that the overall mean Kmax in those with keratoconus was 48.7 diopters, and the majority of the participants with keratoconus were not able to see better than 0.2 LogMAR.[9] A factor that may account for this difference could be because people of Asian ethnicity were reported to have a more severe form of keratoconus when compared to other ethnicities.[16] Since both keratoconic individuals in this study came from Asian backgrounds, it may be why the Kmax values and VA values indicate a more severe case of keratoconus. Other factors may also contribute to this difference

such as the age of diagnosis and availability of treatment. Additionally, the New Zealand study compared 10 keratoconus individuals, whereas this study only had 2. This could account for why the average Kmax and average best corrected distance VAs in this study were slightly more severe, due to the limited number of keratoconic individuals.

Possible risks and associated factors of keratoconus among high school students in Couva, Trinidad

Existing literature shows risk factors that are associated with keratoconus such as parental consanguinity, presence of refractive error, family history, eye rubbing, having atopic diseases, ethnicity and sunlight exposure.[2] The only statistically significant risk factor associated with keratoconus found in this study was having a family history of keratoconus (OR = 142.333, 95% CI: 7.119–2845.711; p=0.001). However, this is in keeping with the findings of other studies which have also found that family history is a significant risk factor for developing keratoconus.[3]

Unfortunately, since only 2 persons with keratoconus were found in this study, there was not enough variation in the data for associations between keratoconus and eye rubbing, parental consanguinity, refractive error, sunlight exposure, near work, frequency of changing spectacles and atopic diseases to be found. However, it is important to note that the keratconic individuals did possess multiple risk factors for keratoconus, as they both had refractive error, rubbed their eyes very frequently and had atopic diseases.

In this study, if a student possessed three or more of the following risk factors: presence of refractive error, eye rubbing (rated a 3/5 or more), parental consanguinity, family history of keratoconus, presence of atopic disease(s) and sunlight exposure (more than 8 hours per week), near work (more than 24 hours per week), or changing his/her spectacles at least once a year, he/she was considered to be at risk for developing keratoconus. The findings revealed that 47.7% of the participants were found to be at risk of developing keratoconus. This could be due to the dusty, pollen-heavy atmosphere here in Trinidad which leads to eye rubbing in many students.

This finding was higher than 34.5% reported to be at risk in a study among high school students in Cameroon.[3] There is need to use larger sample and conduct a population-based keratoconus study in Trinidad.

The presence of atopic diseases was also quite abundant in the study population. One study done in Europe aimed at determining the prevalence of atopic diseases in adolescents found it to be 40.3%.[39] The fact that this study was conducted on a much smaller sample size yet still found similar results (48.4%), shows that atopic diseases are prevalent among high school students in our society and thus, they can contribute as a risk for many persons.

Moreover, sunlight exposure has also been linked to keratoconus development as exposure to UV rays can have a thinning effect on the cornea.[3] This is obviously a very prominent risk factor in our study as everyone is exposed to the sunlight daily due to our tropical climate. Due to this sunny weather, it is a culture in Trinidad that persons of the adolescent age often engage in outdoor-based activities as a form of extra-curricular or leisure. This could account for why more than half of the participants (51.4%) stated that they spend more than 8 hours in the sun per week. This increased sunlight exposure can encourage the development of keratoconus in the adolescent population.

Although there were no associations found with other risk factors such as presence of refractive error, parental consanguinity, near work, frequently changing spectacles, these risk factors were still quite present in the study population. For example, 32.9% of our study participants had refractive error which was higher than 6.7% recorded in a study among school children in East Sikkim.[40] Additionally, a study done in 2010 estimated that the global prevalence of parental consanguinity of the global population is 10.4%.[20] In this study, 10% of the participants had

parents that were related. This is a very similar figure to that of the global prevalence of parental consanguinity. Therefore, the fact that the prevalence in such a small area is similar to that of the global prevalence of parental consanguinity, means that this risk factor of keratoconus might be prevalent in Trinidad.

Several studies have put forth the idea that persons of Asian ethnicity tend to develop keratoconus more frequently compared to persons of other ethnicities.[17] 48.1% of the participants in this study were of East Indian descent, therefore, nearly half the study population consisted of those of Asian descent. Trinidad's society is comprised of a large Asian population therefore, this risk factor for keratoconus might be high in Trinidad. Although no association could be found between those at risk and ethnicity, the majority of those at risk were of East Indian descent (47.6%). Since most of the risk factors for keratoconus are common in Trinidad, it is not surprising that nearly a half of the study population possessed three or more of these risk factors and are at risk of developing keratoconus.

More females (54.4%) were at risk of developing keratoconus than males. This finding is in agreement with some studies which found that keratoconus tends to be more present in females than males,[13] but differs from the findings of other studies that conclude that keratoconus is more present in males.[15] Thus, more research needs to be conducted to find out if there really is an association between keratoconus and gender as different studies tend to report different conclusions on this matter.

Lastly, no association could be found between age and those at risk of developing keratoconus however, the majority were 14 years old (35.9%). This again supports similar findings which show that the mean age of keratoconus diagnosis can be around 14.9 years old.[9]

Awareness of keratoconus in high school students in Couva, Trinidad

The awareness of keratoconus recorded in this study was 39 (9.0%) out of 432 participants. This shows that the awareness of keratoconus among high school students was generally low as more than 90% of the participants had never heard of the disease. There is a lack of education on this disease in Trinidad and people who were determined to be at risk of developing keratoconus do not know that they are susceptible to this disease. High school students, and their parents, should be aware of this disease so that they can go for regular eye exams and get screened for keratoconus. Other studies done in Saudi Arabia among the public on the awareness of keratoconus also reported very low levels of awareness.[30] There is a need for more eye health education among high school children in Trinidad.

Limitations

- The sample size was small and thus, only 2 persons with keratoconus were found. This limited the researchers' ability to find more risk factors associated with keratoconus.
- This study was susceptible to participants' honesty and responsiveness to the questionnaires.
- Findings from the study cannot be generalized as it was only conducted in secondary schools in Couva.

Conclusion

This study was the first of its kind to be done in Trinidad and by extension, the Caribbean. The prevalence of keratoconus was found to be 1 in every 216 high school students (0.46%), with the clinical presentation and demographic distribution of keratoconus being identical to findings in existing literature. Having a family history of keratoconus was found to be an associated factor in those with keratoconus. 47.7% of the participants had 3 or more risk factors, making them at risk for developing keratoconus. Further comparison of the data to findings in other studies showed that the risk factors for keratoconus such as refractive error, parental consanguinity, atopic diseases, sunlight exposure and eye rubbing were present in a large number of the study population.

It is believed that with a bigger sample size, the prevalence of keratoconus in Trinidad would be even higher. The poor awareness of keratoconus in the study population showed that many are not educated about this condition or its risk factors, meaning that late diagnosis and treatment for keratoconus may be quite common in Trinidad, which does not promote the best visual

outcomes. This study aims to stress the importance for regular eye exams and screening for keratoconus in the adolescent population in Trinidad due to the many individuals who meet the risk factors for developing keratoconus.

Recommendations

- Future studies should include a larger sample size and include more schools so that the results can be generalized to the entire country.
- Similar studies should be conducted in other Caribbean islands.

Next Steps

- Expand the sample size to discover more people with keratoconus.
- Expand the area of study to cover secondary schools spread throughout Trinidad.

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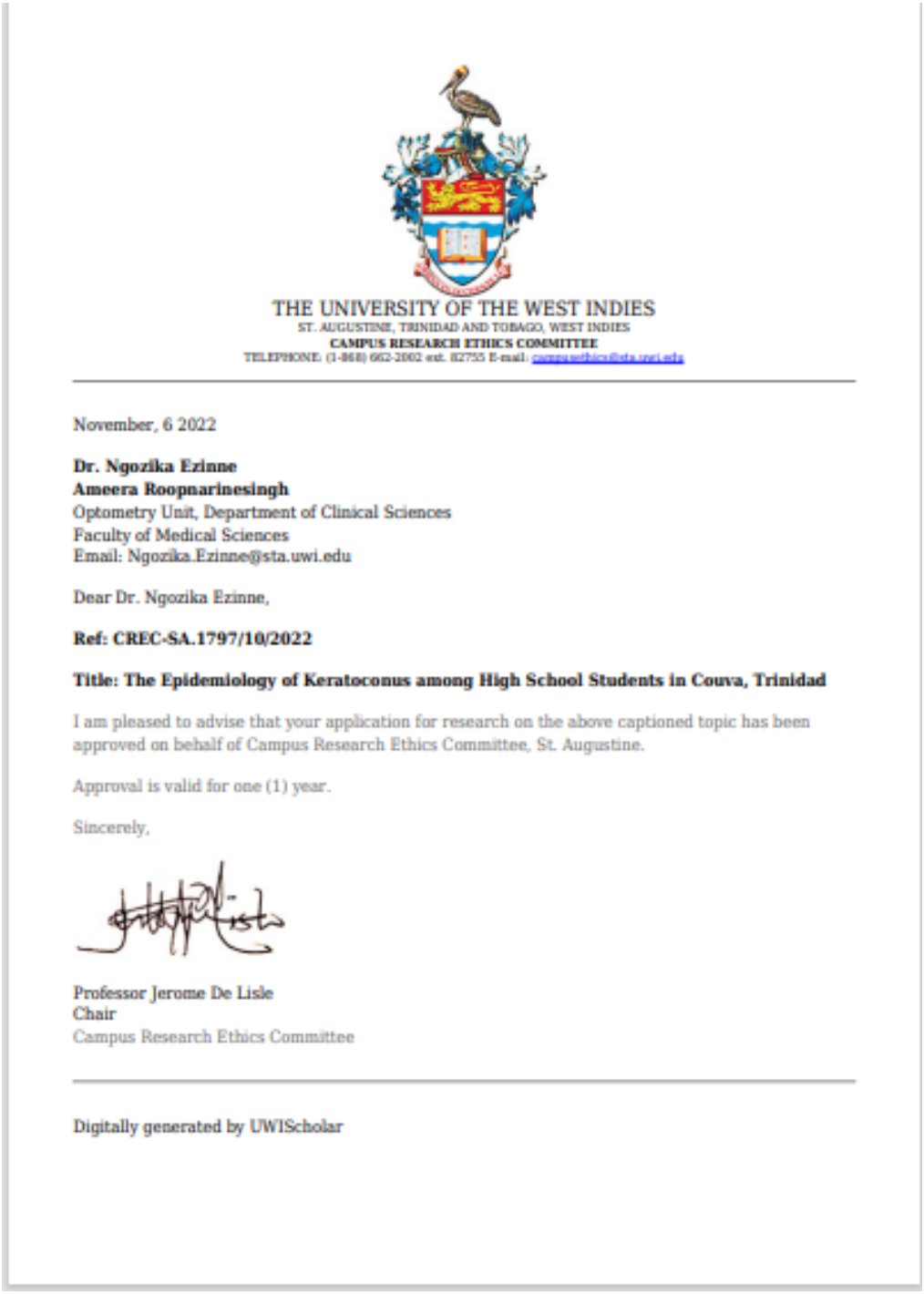
Appendix

1. *Campus Research Ethics Committee Approval Letter*



THE UNIVERSITY OF THE WEST INDIES
ST. AUGUSTINE, TRINIDAD AND TOBAGO, WEST INDIES
CAMPUS RESEARCH ETHICS COMMITTEE
TELEPHONE: (1-868) 662-2002 ext. 82755 E-mail: [illegible]

November, 6 2022

Dr. Ngozika Ezinne
Ameera Roopnarinesingh
Optometry Unit, Department of Clinical Sciences
Faculty of Medical Sciences
Email: Ngozika.Ezinne@sta.uwi.edu

Dear Dr. Ngozika Ezinne,

Ref: CREC-SA.1797/10/2022

Title: The Epidemiology of Keratoconus among High School Students in Couva, Trinidad

I am pleased to advise that your application for research on the above captioned topic has been approved on behalf of Campus Research Ethics Committee, St. Augustine.

Approval is valid for one (1) year.

Sincerely,

Professor Jerome De Lisle
Chair
Campus Research Ethics Committee

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2. Ministry Approval Letters

Government of the Republic of Trinidad and Tobago
MINISTRY OF EDUCATION
Education Towers, No.5 St. Vincent Street, Port of Spain, Trinidad
1.868.622.2181 Ext. 2342, (Fax) 1.868.624.1222, www.moe.gov.tt
Educational Planning Division
Level 14

E: 14/4/16

November 3, 2022

Dr. Ngozika Ezinne, Ms. Destiny Lawrence and Ms. Elicia Bissoon
Optometry Unit
Department of Clinical Surgical Sciences
University of the West Indies

Dear Dr. Ezinne, Ms. Lawrence and Ms. Bissoon,

Your request to include additional schools in your study entitled **"Epidemiology of Keratoconus among High School Children in Trinidad and Tobago"** has been approved by the Chief Education Officer of the Ministry of Education.

This approval is granted for the academic year 2022/2023 and permits the researchers to include six (6) additional schools in their study within the Ministry of Education (see attached list).

Should you require additional information please contact Ms. Jermaine Williams, Research Officer I, Educational Planning Division at 622-2181 ext. 2334 or jermaine.williams@moe.gov.tt.

Yours sincerely,

.....

Director
Educational Planning Division

CERTIFIED CORRECT

RESEARCHER: DR. NGOZIKA ESTHER EZINNE, MS. DESTINY LAWRENCE AND MS. ELICIA BISSOON

List of Schools

Caroni Education District

1. Couva East Secondary School
2. Couva West Secondary School

South Eastern Education District

1. Barrackpore East Secondary

Victoria Education District

1. Debe Secondary School
2. Marabella North Secondary School
3. San Fernando Central Secondary School

Total No. of Schools: 6

CERTIFIED CORRECT

Government of the Republic of Trinidad and Tobago
MINISTRY OF EDUCATION
Education Towers, No.5 St. Vincent Street, Port of Spain, Trinidad
1.868.622.2181 Ext. 2342, (Fax) 1.868.624.1222, www.moe.gov.tt
Educational Planning Division
Level 14

E: 14/4/16

February 22, 2023

Dr. Ngozika Ezinne, Ms. Destiny Lawrence and Ms. Elicia Bissoon
Optometry Unit
Department of Clinical Surgical Sciences
University of the West Indies

Dear Dr. Ezinne, Ms. Lawrence and Ms. Bissoon,

Your request to include additional schools in your study entitled "**Epidemiology of Keratoconus among High School Children in Trinidad and Tobago"** has been approved by the Chief Education Officer of the Ministry of Education.

This approval is granted for the academic year 2022/2023 and permits the researchers to include six (5) additional schools in their study within the Ministry of Education (see attached list).

Should you require additional information please contact Ms. Jermaine Williams, Research Officer I, Educational Planning Division at 622-2181 ext. 2334 or jermaine.williams@moe.gov.tt.

Yours sincerely,

.....
Director
Educational Planning Division

CERTIFIED CORRECT

RESEARCHER: DR. NGOZIKA ESTHER EZINNE, MS. DESTINY LAWRENCE AND MS. ELICIA BISSOON

List of Schools

Caroni Education District

1. Waterloo Secondary School
2. Holy Faith Convent, Couva

Victoria Education District

1. A.S.J.A. Girls' College, San Fernando
2. Presentation College, San Fernando
3. San Fernando West Secondary School

Total No. of Schools: 5

CERTIFIED CORRECT

Government of the Republic of Trinidad and Tobago
MINISTRY OF EDUCATION
Education Towers, No.5 St. Vincent Street, Port of Spain, Trinidad
1.868.622.2181 Ext. 2342, (Fax) 1.868.624.1222, www.moe.gov.tt
Educational Planning Division
Level 14

E: 14/4/16

February 22, 2023

The School Supervisor III
Caroni District Office
Old Couva West Secondary
School, Balisier Street,
Couva

Dear Sir/Madam

This is to inform you that **Dr. Ngozika Esther Ezinne, Ms. Destiny Lawrence** and **Ms. Elicia Bissoon** have been granted permission to include Waterloo Secondary School and Holy Faith Convent, Couva in their research within your Education District. Dr. Ezinne is an Optometry Lecturer at the University of the West Indies, St. Augustine Campus and the principal investigator in the study. Ms. Destiny Lawrence and Ms. Elicia Bissoon are co-investigators. Their research is entitled **"Epidemiology of Keratoconus among High School Children in Trinidad and Tobago."**

The applicants' research shall be conducted during academic year 2022/2023. In this regard, you are kindly asked to inform the Principals of the schools within your District to expect the researchers. Participation is voluntary; however, the Principals' cooperation in assisting the researchers would be greatly appreciated.

Should you require additional information please contact Ms. Jermaine Williams, Research Officer I, Educational Planning Division at 622-2181 ext. 2334 or jermaine.williams@moe.gov.tt.

Yours sincerely

.....
Director
Educational Planning Division

CERTIFIED CORRECT

Government of the Republic of Trinidad and Tobago
MINISTRY OF EDUCATION
Education Towers, No.5 St. Vincent Street, Port of Spain, Trinidad
1.868.622.2181 Ext. 2342, (Fax) 1.868.624.1222, www.moe.gov.tt
Educational Planning Division
Level 14

E: 14/4/16

November 3, 2022

The School Supervisor III
Caroni Education District Office
14 Camden Court
Couva

Dear Sir/Madam

This is to inform you that **Dr. Ngozika Esther Ezinne, Ms. Destiny Lawrence** and **Ms. Elicia Bissoon** have been granted permission to include Couva East Secondary School and Couva West Secondary School in their research within your Education District. Dr. Ezinne is an Optometry Lecturer at the University of the West Indies, St. Augustine Campus and the principal investigator in the study. Ms. Destiny Lawrence and Ms. Elicia Bissoon are co-investigators. Their research is entitled **"Epidemiology of Keratoconus among High School Children in Trinidad and Tobago."**

The applicants' research shall be conducted during academic year 2022/2023. In this regard, you are kindly asked to inform the Principals of the schools within your District to expect the researchers. Participation is voluntary; however, the Principals' cooperation in assisting the researchers would be greatly appreciated.

Should you require additional information please contact Ms. Jermaine Williams, Research Officer I, Educational Planning Division at 622-2181 ext. 2334 or jermaine.williams@moe.gov.tt.

Yours sincerely

.....
Director
Educational Planning Division

CERTIFIED CORRECT

3. Ministry Permission Letter

Optometry Unit, Department of Clinical Surgical Sciences,
Faculty of Medical Sciences,
University of the West Indies

The Permanent Secretary
Ministry of Education
5 St. Vincent Street
Port of Spain

The Chief Education Officer

Dear Sir,

Re: Permission to Conduct Research in Secondary Schools

Our names are Shinead Phagoo and Ameera Roopnarinesingh. We are Optometry students at the University of the West Indies, Saint Augustine Campus. We intend to do research as part of the requirements for us to graduate from Optometry. Our research is titled "The Epidemiology of Keratoconus Among High School Students". Our supervisor for this research project is Dr. Ngozika Ezinne.

This research project aims to determine the prevalence of Keratoconus amongst students in secondary schools, as well as deduce risk factors that may contribute to one developing the disease. Keratoconus is an abnormality of the cornea that is commonly found in children, which could lead to visual impairment, and that has the potential of affecting educational outcomes and limiting potential future employment. We chose to conduct this study on high school students because the condition is known to be common among young adults and children.

The purpose of this letter is to ask for your permission to screen secondary school students to detect students who could have or be at risk of having this problem. The screening will not involve direct contact with the eyes and will not cause any form of discomfort or injury to the students. The screening will involve checking their vision with a vision chart, scanning their cornea using a retinoscope, and measuring their refractive error using a hand-held autorefractor. Ethical clearance has been obtained from the UWI Research and Ethics Committee. The following schools have been selected for the screening:

1. Preysal Secondary School
2. Couva East Secondary
3. Waterloo Secondary School

Thank you in advance for your time and cooperation.

Regards,
Shinead Phagoo and Ameera Roopnarinesingh

4. Parent Consent Form

Information on Keratoconus Research Project

Research Title: The Epidemiology of Keratoconus and Associated Risk Factors in High School Students in Couva, Trinidad

Principal Investigator: Dr. Ngozika Ezinne

This research is being conducted by Dr. Ngozika Ezinne, who is a lecturer in the Optometry Unit at UWI, St. Augustine, as well as Shinead Phagoo and Ameera Roopnarinesingh who are Optometry students at UWI, St. Augustine.

Keratoconus is the bulging of the cornea (the clear outer layer of the eye) in a cone-like shape. It is a corneal defect that presents itself in young children and adults - up to age 22. This corneal defect can affect the vision, in turn affecting a person's quality of life and employability. Like Trinidad and Tobago, keratoconus is most common in warm and sunny climates. Although there are some obvious symptoms of this corneal defect, not all persons may experience these symptoms. Early detection- through screening- and management is essential to improving the quality of life offered to persons. Hence, through this research project we hope to identify teenagers who may have keratoconus.

Due to the government having little to no information on the spread of keratoconus among high school students, its ability to plan various interventions is limited.

Purpose of Research: This research project is being conducted to determine the prevalence of keratoconus in high school students in Couva, and to determine who is at risk for developing the disease.

Duration of this Research Project: Initial screening should take approximately 20 minutes which will take place at the secondary school that your child attends. This screening will be done during break times and free periods so that class time will not be interrupted. Should your child/ward show risks of having keratoconus, they will then be asked to visit the Couva Medical and Multi-Training Facility in order to do further tests to determine if they have keratoconus.

How was my child/ward selected? Our study focuses on students between ages 12-17 from forms 1-5. Three schools were randomly selected from Couva based on their proximity to the Couva Medical and Multi Training Facility. A total of one hundred and forty-eight (148) students from your child/ward's respective school will be selected, where thirty (30) students from each form will be selected to participate. Your child/ward is one of 30 randomly selected students from their respective forms.

What will happen to my child/ward?
The initial screening done at the school will consist of the following:

1. Completing a questionnaire: The questionnaire consists of questions to find out if your child is at risk of having Keratoconus or has a family history.

Based on the results of the questionnaire, your child/ward may be asked to participate in some clinical assessments which will consist of the following:

2. The visual acuity of the students will be taken by placing a chart with letters 6 meters away from a seated patient. Your child will be asked to read the smallest line of letters

they can see first with their right eye covered, then with their left eye covered and finally with both eyes open to know how much they can see.

3. The retinoscope is a handheld device that shines a light onto the patient's eye. The examiner will stand about an arm's length away from the student and briefly pass the light over the patient's eye a few times. The patient will experience no discomfort as the light is not bright and the process is very quick.
4. The autorefractor will be used to determine the refractive status of the student. The student will be asked to align their eyes with the eyepiece of the machine. The examiner may have to adjust the device according to the patient's eye alignment. Once properly aligned, the device will automatically take the patient's refractive error using wavefront technology. The patient will not feel any pain or discomfort and will not realize the process is occurring.

Finally, if signs of keratoconus are detected during these screenings, the student, and their parent, will be asked to come to the Couva Medical and Multi Training Facility to use the topographer. The topographer is another machine that can give us more information about a patient's cornea. It requires the patient to place their chin on a chin rest and their forehead against a forehead bar. The patient is just required to look straight ahead into the machine while the machine takes the measurements. It is a painless process and the patient will experience no discomfort.

What benefits are available for my child/ward? This research project can be beneficial to the student as it can help to identify if the student has or is at risk of having keratoconus. Should a student be identified as having keratoconus, the relevant treatment will be recommended.

What will your child/ward be responsible for during this study? Your child/ward will be responsible for truthfully answering all questions in the questionnaire and allowing for the initial screening to take place at their secondary school based on the results of the questionnaire. If necessary, they will also be responsible for allowing the follow-up screening at the Couva Medical and Multi Training Facility.

Are there any risks involved? No tests which can harm the student will be done throughout the duration of their participation as all tests are non-invasive.

How long will the investigators use and share my child/ward's information? The information collected will be stored for a duration of 5 years or until the research is published. The final publication of the research will contain no identifiable information about your child/ward.

Are there any expenses to me or my child/ward? The screenings that will be done at your child's/ward's secondary school are free of charge. If your child/ward has to be referred to Couva Medical and Multi Training Facility to use the topographer, this will also be free of charge. The parent of the child will be asked to bring the child into the clinic on a date and time agreed upon by the student, parent and research investigators. If the parent is unable to being the child in themselves, a travel allowance will be given for both the child and the parent so that they can come into the clinic. However, if keratoconus is detected, any further treatment whether at the Couva Medical and Multi Training Facility, other Optometrists or Ophthalmologists will be at your own cost.

Confidentiality: The name and any identifying information of the student will not be shared in the results of the research nor in future research studies. Any identifiable information that

needs to be collected for follow up purposes will only be accessible by the researchers and will be discarded one data collection is complete.

Right to refuse or withdraw: Your child/ward can refuse to participate in this research study by their free will. Participation is voluntary and without fee. The student can withdraw from participation at any time with NO penalties. We assure you that no harm will be done to your child/ward. Questions from you and/or your child/ward are welcomed and will be answered to your satisfaction. For further information/clarification, you can contact 786-7961.

This study has been approved by the Ministry of Education and the Campus Research Ethics Committee at the University of the West Indies, St. Augustine.

Parent Consent Form ~~For~~ Participation in a Keratoconus Research Project

I have read or have been read the information given to me and understand it very well. I have had the opportunity to ask questions about this research and I have been given answers to my satisfaction. I understand my child/ward can withdraw at any point in time without penalties.

Please tick the appropriate box below:

- ☐ I hereby give consent for my child/ward to participate in the research stated in this ~~document~~
- ☐ I hereby do not give consent for my child/ward to participate in the research stated in this ~~document~~

(Parent/Guardian Name in Block Letters)

(Parent/Guardian ~~Signature~~) (Date)

5. Student Assent Form

ASSENT TO PARTICIPATE IN RESEARCH

1. Our names are Shinead Phagoo and Ameera Boopnarinesingh. We are Optometry students at UWI, St. Augustine and we are under the supervision of Dr. Ngozika Ezinne who is a lecturer in the Optometry Unit at UWI, St. Augustine.

2. We are asking you to take part in a research study because we are trying to learn more about how many children of your age have an eye problem called keratoconus, which we have found is very common among children of your age.

   What is keratoconus? This is an eye problem that makes the part of your eye called the cornea to be abnormal in shape. It can cause children of your age to rub their eyes a lot, have problems with bright light and not see things clearly even when they use glasses.

3. If you agree to be in this study, you will first be given a permission form to be signed by your parents. If permission is given, you will be given a questionnaire to be answered. This questionnaire will ask questions about your eyes. Based on the answers in the questionnaire, we may then carry out some visual screening tests.

   What will this screening involve?
   The initial screening done at the school will consist of the following:

- Completing a questionnaire: It consists of questions to find out if you are at risk of having keratoconus. We will ask you questions about if you rub your eyes a lot, if light disturbs you a lot, if you wear glasses or change your glasses a lot, or if there is food or any other things that you are allergic to. These questions will help us to know if you are at risk of having keratoconus either now or in the future.

  Based on the results of the questionnaire, we will proceed with some clinical assessments which are explained below:

- We will check how well you see by using a chart that has letters or numbers. We will place the chart at a distance 6 meters away from you and cover one of your eyes. We will ask you to read out the letters you can see out loud. We will also ask you to do this with other eye covered instead, and then both eyes open.

- We will also use a small instrument called a retinoscope to shine light into your eyes. The light will not cause you any pain or discomfort as the light is not bright and the process is very quick

- We will also use another small instrument called an autorefractor to measure the prescription of your eye. You will be asked to place your eye in front of the machine and then we will take the measurement. You will not feel any pain or discomfort and will not realize the process is occurring.

  If the results of the questionnaire and screening show that you have signs of keratoconus, we will ask your parents to bring you to our clinic in the Couva Medical

and Multi Training Facility. In Couva we will use another instrument called a topographer to check the shape of the cornea of your eye to confirm if you really have this eye problem. In taking measurements with the topographer, we will be required to place your chin on a chin rest and your forehead against a forehead bar on the instrument. You are just required to look straight ahead into the machine while the machine takes the measurements. It is a painless process, and you will experience no discomfort. There will be no harm done to you at any point during the screening.

4. If you are at risk of having keratoconus, we will inform you. This screening will be free of charge to both yourself and your parent/guardian. The recommended treatment will be advised if you have keratoconus.

5. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say "yes", you can still decide not to do this.

6. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.

7. You can ask any questions that you have about the study. If you have a question later that you didn't think of, you can call us at 749-7542 / 494-4748 or ask us next time.

8. *Please tick the appropriate box below:*

☐ I am agreeing to participate in this research project

☐ I am not agreeing to participate in this research project

_____ _____

Signature of Child Date

_____ _____

Signature of Investigator Date

6. Questionnaire

KERATOCONUS RISK INVESTIGATIVE SURVEY

Thank you for taking the time to complete this KERATOCONUS RISK INVESTIGATIVE SURVEY. All information obtained will be kept confidential.

Please tick the appropriate box for each question.

Please feel free to provide additional details/requests at the end of the survey if you feel that the questions did not adequately cover your specific case.

THANK YOU!

Today's date	
Name	
Age	
Gender	
Nationality	
Ethnic/Tribal Group	
Religion	
Contact Number	
School	
Form Class	

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

1. Have you heard of the eye condition called Keratoconus?

Yes	
No	

2. If yes, how would you rate your knowledge of Keratoconus on a scale of 1 (no knowledge) to 5 (excellent knowledge)?

1	2	3	4	5

3. Has anyone in your family been diagnosed with Keratoconus?

Mother	
Father	
Brother/Sister	
Cousin	
No relative	

4. Are your parents blood relatives/related to each other (Consanguinity)?

1st cousins	
2nd cousins	
Distant relatives	
Not related	

5. How many hours, on average per week, do you spend outside in the sunlight?

HOURS	
Less than 8 hours	
8-24 hours	
>24 hours	

6. How many hours, on average per week, do you spend doing near tasks (reading/using your cellphone/computer games)?

HOURS	
Less than 8 hours	
8-24 hours	
>24 hours	

7. Tick the foods that you eat at least twice a week?

FOOD	
Fish/Chicken	
Red Meat	
Eggs	
Beans	
Milk	
Rice/Pap/Pasta/Bread	
Vegetables	
Fruit	

SECTIONB: CLINICAL PROFILE

8. Do you have any of the following atopic diseases/allergies?

ATOPIC DISEASES/ALLERGIES	
Eczema (skin rash)	
Hayfever	
Vernal Keratoconjunctivitis (VKC)	
Asthma	
Food allergies	
Pollen/dust allergies	
Animal fur allergies	

9. Do you have any of the following systemic diseases?

SYSTEMIC DISEASE	
Down syndrome	
Osteogenesis imperfecta	
Ehlers-Danlos syndrome	

10. Do you wear glasses?

Yes	
No	

11. If yes, how well do you see through your glasses on a scale of 1 (very blurry) to 5 (very clear)?

1	2	3	4	5

12. If you do wear glasses, how often do you need to change your spectacles?

TIME FRAME	
Every 6 months	
Every year	
Every 2 years	
Less than every 2 years	
Never changed	

13. How would you rate yourself on how often you rub your eyes on a scale of 1 (never) to 5 (very often)?

1	2	3	4	5

14. How sensitive are you to bright lights on a scale of 1 (not sensitive) to 5 (very sensitive)?

1	2	3	4	5

15. Do you wear/have you worn rigid contact lenses?

Yes	
No	

16. Have you had LASIK eye surgery previously?

Yes	
No	

THANK YOU FOR PARTICIPATING IN THE SURVEY