https://dx.doi.org/10.4314/jnoa.v25i1.4

# Association between Outdoor Play and Myopia among Children in Cross River State, Nigeria. A Case Control Study.

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## Abstract

**Purpose**: Myopia is a refractive error of the eyes that causes blurred distance vision. Near work, genetics and environmental factors have been implicated as risk factors in Child myopia. This study seeks to determine the association between time spent on outdoor play and myopia among children in Calabar, Nigeria.

**Methods**: It was a hospital-based case-control study conducted among 120 children (5-17 years old) selected and matched by age and sex from out-patients of the Cross River Eye Care Program. After obtaining parental consents, assent was obtained from the children before conducting comprehensive eye examinations. Myopia was defined as a spherical equivalent of ≥-0.50D. Cases were children diagnosed with myopia and controls were those without myopia. Independent samples t-test and Spearman's correlation were conducted and P-value < 0.05 was considered to be statistically significant at 95% confidence interval.

**Results**: Cases spent lesser time playing outdoors than controls (M = 1.95 vs 2.40 hours daily, $p = 0.01$). Spearman's correlation found a statistically significant, weak, negative correlation between time spent on outdoor play and myopia [$r_s(118) = -0.217$, $p = 0.017$]. Spending above 2 hours on outdoor play had an OR of 0.37 (95% CI = 0.170 - 0.816).

**Conclusion**: In this association found between time spent on outdoor play and myopia, as time spent on outdoor play increases, myopia decreases. Increased time spent on outdoor play was a protective factor against myopia. Hence it is recommended that more awareness be created on the protective effect of outdoor play.

**Keywords:** Association, children, myopia, outdoor play, time spent.

## Introduction

Myopia has received global attention as a health problem owing to the resultant vision impairment that eventually leads to blindness[1]. Myopia impacts negatively on quality of life, with social, educational and economic ramifications, thereby becoming

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a disease of public health importance[2]. About 1.2 million children worldwide between the age of 5 and 15 have visual impairment from refractive errors such as myopia[3]. A Child with myopia is at risk of developing sight-threatening complications and permanent visual impairment that may affect the child's social, educational and psychological development[4]. Visual impairment from myopia can be improved through use of spectacles, contact lenses and/or surgery, however, myopia tends to progress overtime with blinding complications such as retinal detachment, subretinal neovascularization, cataract, and glaucoma[5].

There is variation in the prevalence of myopia across countries, ages and ethnicity, nevertheless it remains the major cause of visual impairment in low, medium and high-income countries.[2] About 27% of the world (1.45 billion) had myopia in 2010, and about 50% (4.8 billion) are predicted to become myopic by 2050, a dramatic and alarming increase from 27% estimated in 2010[6,7,8]. These projections suggest an epidemic increase in global myopia prevalence, implying a need for more attention on myopia control. Around the globe, the prevalence of myopia varies. It is reported as 64.9% in China, 62.0% in Singapore, 56.0% in Taiwan, 20.0% in the United States, 10.9% in Australia, 9.7% in urban India and 19.2% in Vietnam[9]. Reports from Africa have been relatively lower with 2.6% and 4.0% prevalence in Ethiopia and Uganda respectively[4], up to 9.6% in South Africa and 1.7% in Ghana[10]. In Nigeria, a prevalence of 2.7% among 8-15 year-old children was found in Abia State,[9] 2.9% in Kebbi State[11], and 13.8% in Bayelsa State[12]. In Cross River State where myopia had been identified as the major refractive cause of blindness[13], a myopia prevalence of 4.8% in school learners aged 10 -18 years had been recorded[14]. These prevalence rates indicate that myopia is of public health concern.

Certain risk factors have been implicated in the increase in myopia across the world. These include intensive education, body mass index (BMI) and limited time outdoors[15]. Others are genetics (parental myopia)[6], and environmental factors such as outdoor activities and increasing near work load which has been described to include reading, writing, computer use and playing of video games[5]. However, it is anticipated that some behavioral changes could offer some form of protection[16]. The possibility that outdoor activity could be a risk

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factor, or a protective factor has globally excited vision scientists in the eye care world. Some have suggested that spending greater time under the sun in the open might be associated with lesser chances of myopia. One school of thought demonstrated causality and linked this association to the light dopamine theory, which supposes that the high intensity of light found outdoors would stimulate the release of dopamine[17], which in turn reduces the axial elongation of the eye[18] that precipitates myopia. Although this mechanism of action remains poorly understood it seems to lend support from the difference in rates of progression usually seen in the summer as compared to winter[6]. Is there an association between outdoor play and myopia among children in Nigeria? There is scarcity of data on myopia association studies in Nigeria, therefore this case-control study seeks to fill this gap and determine the association between time spent on outdoor play and myopia among children in Calabar, Cross River State. It also compared the amount of time spent on outdoor play by children who have myopia and those that do not. The results may be useful to parents and teachers and could guide school authorities in formulating school policies on timetable development. The results will also complement existing data from other climes and thus encourage a holistic approach to clinical management of myopia.

## Materials and Methods

The sample size for this study, including a 15% non-response rate, was 60 (that is, 60 cases and 60 controls), derived from a WHO formula[19], as illustrated below.

$$n = \frac{2(Z_{\alpha} + Z_{(1-\beta)})^2 .p(1-p)}{(p_0 - p_1)^2}$$

Where $Z_{\beta}$ = 80% (0.842); $Z_{\alpha}$ = 1.96, $p_0$ = 64.1% (0.641); $p_1$ = 35.9% (0.359); p = $0.5^2$.

### Sampling procedure

*Eligibility Criteria*

This case-control study was restricted to children who had undergone a comprehensive eye examination as outpatients in the Children Unit of the Cross River State Eye Care Programme, (CRSECP) Calabar, following established corona virus disease (COVID-19) protocols. The examination covered ocular history, visual acuity testing using Snellen charts, ocular motility tests, indirect ophthalmoscopy, autorefraction, cycloplegic refraction (using tropicamide and cyclopentolate) and subjective refraction for best vision correction.

*Inclusion criteria:* Children aged 5-17 years enrolled as cases or controls.

*Case definition:* Myopia was defined as a refractive error ≥ -0.50D in either eye. Hence a case was a child diagnosed to have myopia within the study period.

*Control definition:* A control was a child diagnosed without myopia in the same facility.

*Exclusion Criteria:* All children within the age bracket of 5-17 years who had significant ocular

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pathology (such as corneal opacities, lens opacities, and retinal disorders); Also excluded were children without both parents available for an eye exam. Children whose parents declined participation in the study; and children whose parent(s) had myopia were excluded from the study. This was so designed to control for parental myopia as a confounding factor.

*Selection of cases and controls*

From the CRSECP register, based on the case and control definitions, 300 children were eligible for enrolment, of which 100 were eligible as cases while 200 were eligible as controls. Parents of eligible children were contacted and invited to the study. Written informed consents were obtained from the parents of the participants after which they helped their child fill out a questionnaire eliciting information among which was how much time in hours did a child spend playing outside the house in a weekday and weekends. Outdoor play included all sorts of sporting activities carried out in the open such as football, court-based games, racing and tracking events, skipping, dancing, etc. The questionnaire was pretested with 10% of the sample size selected randomly from an eye clinic in Calabar. A Table of Random Numbers was used to randomly select 60 cases and 60 controls concurrently matched by age and sex to control these variables as possible confounding factors.

**Data analysis**

The Statistical Package for Social Science software (IBM SPSS Statistics version 22) was deployed in entering, analyzing data, and tabulating results. Group means of cases and controls were compared using Independent Samples t-test. Spearman's correlation was applied to test for association between time spent on outdoor play in hours and myopia in diopters. Odds ratios (OR) were determined using a 2x2 contingency table where time spent for outdoor play was categorized by exposure into "0 – 2 hours" (non-exposed) and "3 – 5 hours" (exposed). A P-value $< 0.05$ was considered to be statistically significant.

**Ethical considerations**

Informed consent was sought from parents and assent given for their children to participate in the study. The study was conducted in accordance with the Declaration of Helsinki (1964). It was approved by the Cross River State Health Research Ethics Committee in the State Ministry of Health with Reference No. CRS/MPH/HREC/020/Vol.V1/200.

**Results**

There was balance in gender within the study population by matching with 60 males (50%) and 60 females (50%). The respondents ages ranged from of 5 to 17 years. Most of the respondents were 13 to 17 years 78 (65%) while 42 (35%) were younger than 13 years. Majority of the respondents, 70 (58.3%), were in secondary schools while 50 (41.7%) attended Primary Schools. Majority of the respondents (65.8%) spent 0-2 hours daily on outdoor play, while a lesser 34.2% of respondents spent 3-5 hours at play (Figure 1). The range of myopia was between -1.00D to -9.00D (Table 1).

In this study, cases ($M_1 = 1.97$, $SD_1 = 1.025$) spent lesser time on outdoor play than controls ($M = 2.42$, $SD = 0.889$). An independent -samples t-test found the difference to be statistically significant, $d = -0.45$, 95%CI [-0.79, -0.10], $t(118) = -2.570$, $p = 0.01$ (Table 2). Visual inspection of scatter plot and

Normal Q-Q Plots showed no significant outliers in the data and no violation of assumption of normality (Figure 2, 3). Furthermore, the study also found a weak negative but statistically significant correlation between time spent on outdoor play and myopia [ $r_s(118) = -0.217$, $p = 0.017$)] (Table 3). In negative correlation, as one variable increases the other variable decreases. This implies that as time spent on outdoor play increases, myopia decreases.

The hallmark of case-control studies is calculation of Odds ratio (OR). The OR in this study was an estimate of the odds of developing myopia for children who spent over 2 hours/day on outdoor play, compared with children who spend less than 2 hours/day at play. The study found an OR of 0.37 (95% CI = 0.17 - 0.82) (Table 4).

## Discussion

This study found that majority of the respondents (65.8%) spent 0-2 hours daily on outdoor play. This could be as a result of parental restriction to outdoor play stemming from the fear of insecurity, corrupting peer influence, and lack of playing space around the house for some.

The results showed that Cases spent lesser time playing outdoors (M = 1.95 hours daily) than controls (M = 2.4 hours daily). This result is similar to results of an epidemiological study in China where the total time spent in outdoor settings was statistically significantly different among those who had myopia and those without (1.4 versus 1.8 hours daily, P = 0.001)[20].

This study found that children who spend above 2 hours/day playing outdoors were 0.37 times less likely to develop myopia than those who spend less than 2 hours/day at outdoor play, implying that outdoor play was a protective factor to myopia rather than a risk factor. This result agrees with the results of a cohort study[21], which revealed that spending a longer time outdoors offered some level of protection against myopia development. The cohort even identified time spent outdoors as a stronger predictor of incident myopia than time spent playing sports. In like manner, after adjusting for confounding variables, another prospective study found a weak protective effect from outdoor activity with an OR of 0.82, 95% CI: 0.70–0.96), albeit finding no association between near task and myopia (OR 1.10, 95% CI 0.94–1.270)[18].

This study found a statistically significant, weak and negative correlation between time spent on outdoor play and myopia $r_s(118) = -0.217$, $p = 0.017$). This result agrees with the conclusion of an association study which reported a significant association with myopia with a decreased risk of onset (OR 2.67, 95% CI: 1.75 - 4.06)[22]. This finding also harmonises with a number of experimental studies that have established an association between time spent outdoors and myopia[20-23].

The effect of outdoor play and associated activities has attracted considerable attention as a potential

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means of delaying onset of myopia although the mechanism of action is still unclear. The epidemiological studies cited above suggest an association between onset of myopia and time outdoors. The possibility that outdoor activity could be a risk factor, or a protective factor has globally excited vision scientists in the eye care world. Some have suggested that spending greater time under the sun in the open might be associated with lesser chances of myopia, although it is still unclear whether this would prevent onset of delay progression. One school of thought demonstrated causality and thus linked this association to the light dopamine theory, which supposes that the high intensity of light found outdoors would stimulate the release of dopamine and thereby delaying myopia onset[6,17,18]. As found in this study, the negative correlation implies that as time spent on outdoor play increases, myopia decreases. Thus, spending a longer time outdoors offered some level of protection against myopia development[21]. It is therefore safe to say that increased outdoor activity, for example in the neighbourhood, at schools, may help to reduce the increasing prevalence of myopia in youths.

There were limitations to this study, the greatest of which was the COVID-19 pandemic which led to a total lock down thereby restricting movements and foreclosing any plans for a population-based study. It also created a morbid fear of hospitals and clinics in the minds of the public, as such honouring an invitation to a clinic was difficult for parents and even more so when the invitation included children. This contributed to the small sample size that was used in this study. Another limitation of case-control studies is that exposure is measured after the health condition or disease has developed already and this may predispose the result to both recall and observer bias.

## Conclusion

In this study, a weak negative association was found between outdoor play and myopia, and children who spent above 2 hours/day playing outdoors were less likely to develop myopia than those who spent less than 2 hours/day at outdoor play. Thus, as time spent on outdoor play increases myopia decreases. Time spent on outdoor play was associated with lower risk of myopia, implying that outdoor play was a protective factor to myopia rather than a risk factor. There is need to create awareness so as to sensitize and encourage parents, guardians, care-givers and teachers to take advantage of the protective effect of outdoor play and allow their children to have enough time to play under sunshine outdoors. More experimental studies are needed in Nigeria and Africa with larger sample sizes to explore this association between outdoor play and myopia in black children.

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**Acknowledgements**

The authors acknowledge the staff of the Children unit of the Eye Care Project for their cooperation.

**Authorship**

KC: Conceptualization, manuscript drafting, acquisition, analysis and interpretation of data, critical revision of important intellectual content and approval of the version to be published.

BNE: design, analysis and interpretation of data, critical revision of important scientific content and approval of the version to be published.

SCA: data acquisition, manuscript editing and approval of the version to be published.

EOO: data curation, manuscript editing and approval of the version to be published.

**Funding**

This research received no external funding.

**Conflict of Interest**

There were no potential competing financial interest in this study.

**Table 1: Frequency Distribution of Myopic Error of Respondents**

| Myopic error | Frequency | Myopic error (diopters) | Frequency |
|---|---|---|---|
| 0.00 | 60 | 3.50 | 4 |
| 1.00 | 5 | 3.75 | 1 |
| 1.25 | 5 | 4.00 | 1 |
| 1.50 | 8 | 4.50 | 2 |
| 1.75 | 2 | 5.00 | 2 |
| 2.00 | 3 | 5.50 | 1 |
| 2.25 | 3 | 6.00 | 8 |
| 2.50 | 6 | 6.50 | 4 |
| 2.75 | 1 | 8.00 | 1 |
| 3.00 | 1 | 9.00 | 2 |

**Table 2: Comparing mean time spent on outdoor play between cases and controls.**

| Variables | Refractive Status | N | Mean | Std. Deviation | P-value |
|---|---|---|---|---|---|
| Time spent on Outdoor Play | Cases | 60 | 1.950 | 1.032 | p = 0.01* |
| | Controls | 60 | 2.400 | 0.867 | |

| | Levene's Test for Equality of Variance | | t-test for Equality of Means | | | | |
|---|---|---|---|---|---|---|---|
| | F | Sig | t | Degree of freedom | Sig | 95% CI Lower | Upper |
| Time spent on Outdoor Play | 0.021 | 0.885 | 2.570 | 118 | p = 0.01* | -0.797 | -0.103 |

*Significant at P < 0.05 at 95% confidence interval (2-tailed).

**Table 3: Correlation Coefficient between Time spent on Outdoor play and Myopia.**

| Variable | 1 | 2 |
|---|---|---|
| 1. Myopia | | |
| 2. Time spent on outdoor play | -0.217* | |

*p = 0.017 (2-tailed); N=120

**Table 4: A 2x2 contingency table showing determination of odds of exposure to outdoor play.**

| Independent variable | Disease Status | | Total | Odds Ratio (95% CI) |
|---|---|---|---|---|
| | Cases | Controls | | |
| **Outdoor Play Exposure** | | | | |
| Exposed (3 – 5 hours) | 14 (34.1%) | 27 (65.9%) | 41 (100.0%) | 0.37 (0 .17 - 0.82) |
| Non-Exposed (0 – 2 hours) | 46 (58.2%) | 33 (41.8%) | 79 (100.0%) | |
| Total | 60 | 60 | 120 | |

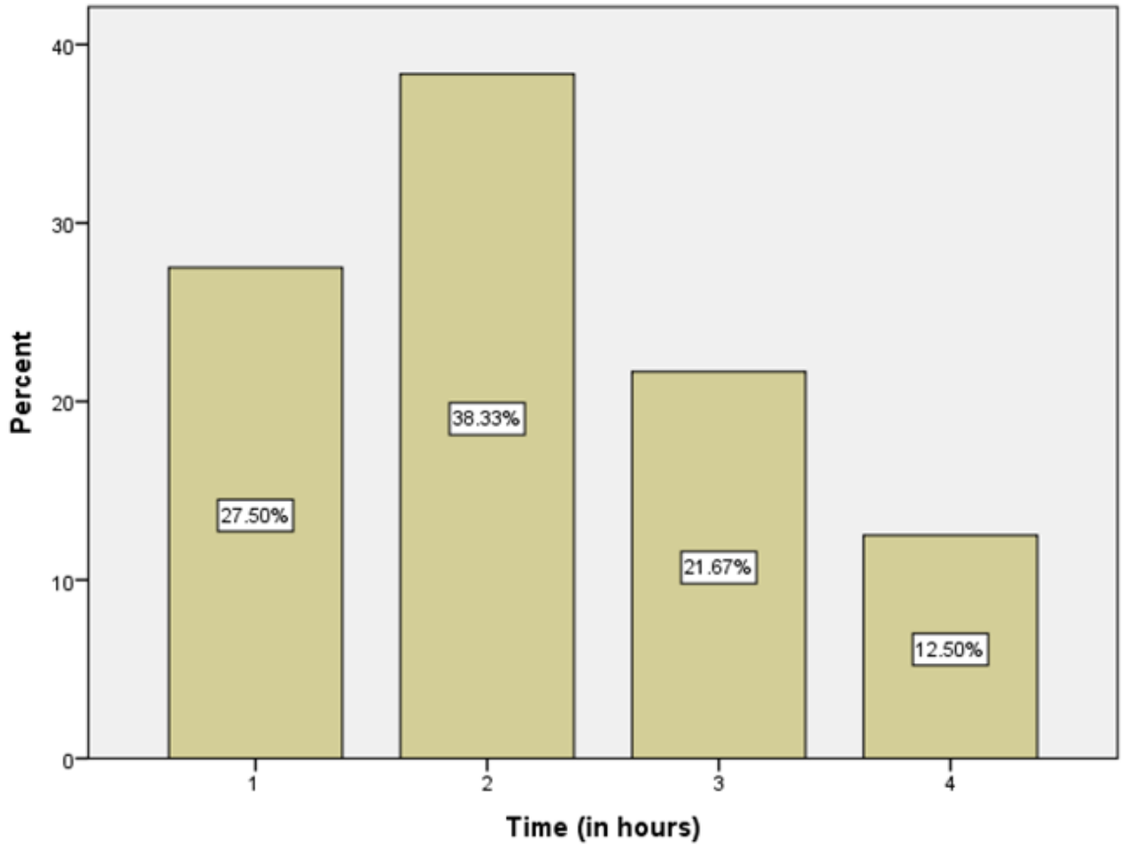


**Figure 1: Daily time in hours spent on outdoor play by respondents**

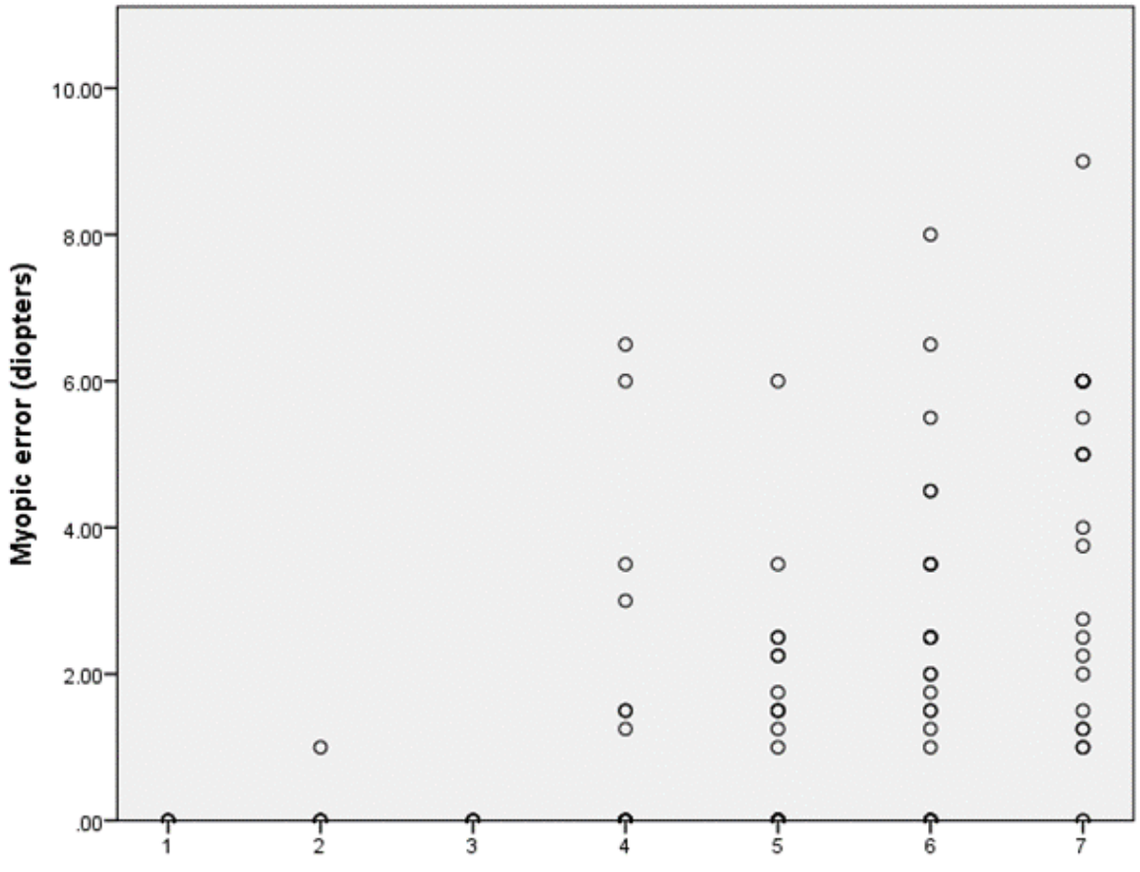


**Figure 2: Scatter plot of Independent Sample T-Test**

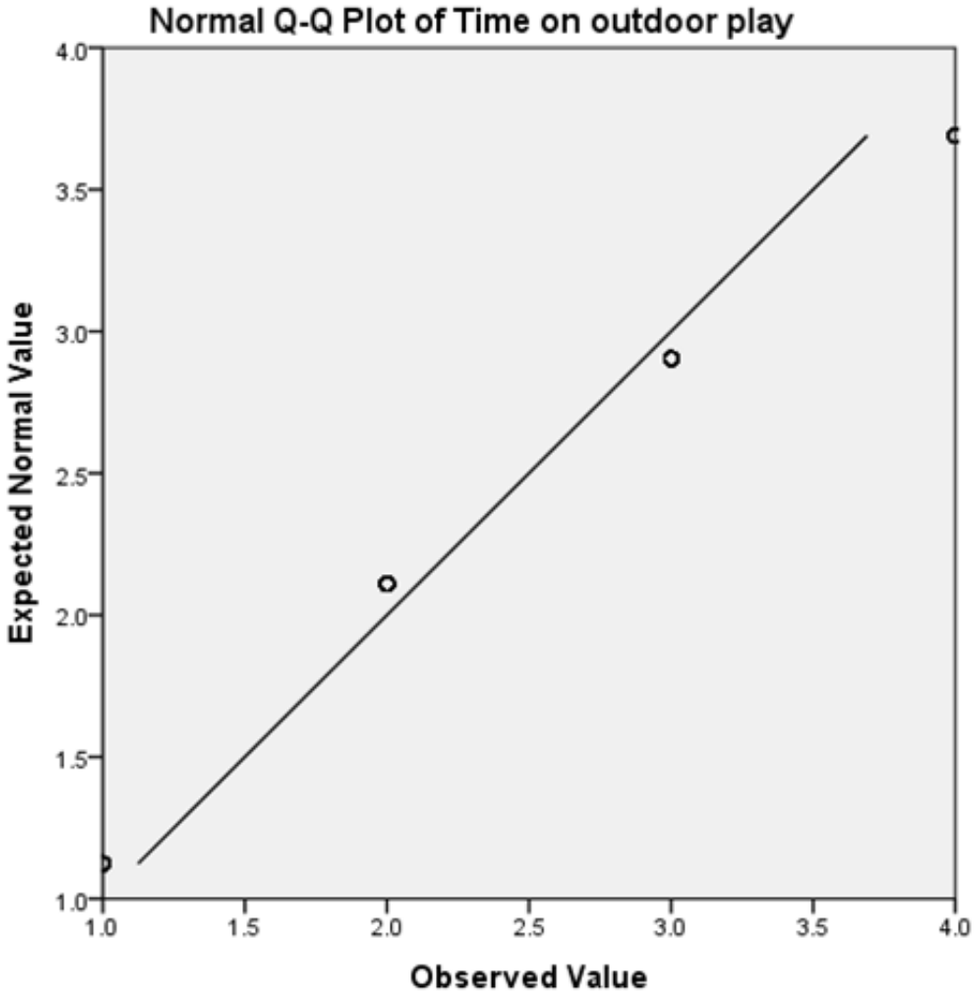


**Figure 3: Normal Q-Q Plot showing normality of Time spent on Outdoor Play**

[ How to cite this article: Charles, K., Ekpenyong, B.N., Agbasimere, S.C., Okoi, E.O. Association between Outdoor Play and Myopia among Children in Cross River State, Nigeria. A Case Control Study. Journal of the Nigerian Optometric Association. 2023;25(1): *10 – 19*]