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Prevalence of eye refractive errors, strabismus, and amblyopia among children referred to eye clinic in secondary hospital, Majmaah city, Saudi Arabia

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ABSTRACT

Introduction: Refractive errors are a preventable cause of blindness in children, resulting in visual disabilities. This study was carried out with an objective to determine the prevalence of common eye refractive errors among children aged between (3 to 15) years and evaluate the number of common eye diseases, strabismus, and amblyopia related to refractive errors as well as preventable and treatable causes of visual impairment. *Materials and methods*: At King Khalid General Hospital Majmaah, a cross-sectional retrospective clinic-based study was conducted among 1477 children aged 3 to 15 years in the tertiary hospital in Saudi Arabia. A full eye examination was performed on 1477 children with both right and left eyes wit a total of 2954 eyes. The mean and standard deviation, as well as the median, are descriptive statistics. The Shapiro-Wilk test was used to determine whether continuous variables were normal. *Result*: This cross-sectional retrospective study included 1477 individuals with 686 (46.4%) males and 791 (53.6%) females. Most children were aged between 11-15 years 833 (56.4%), followed by 7-10 years with 407 (27.6%) individuals. A family history of eye disease was noted in 943 (63.8%) of the children. Out of 1477 children enrolled in the study, Astigmatism was the most common refractive error (47 %), followed by hypermetropia (33%) and Myopia (20 %). While; strabismus in 516 children and amblyopia 427 of total refractive error cases. *Conclusion*: Early diagnosis and treatment of refractive defects, strabismus, and amblyopia reduce strabismus and amblyopia in children and improve their quality of life and education.

Keywords: refractive error, amblyopia, strabismus, hypermetropia, myopia, astigmatism, Majmaah city, Saudi Arabia.

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1. INTRODUCTION

Refractive error is a phenomenon in which light reflects incorrectly on the retina because of the eye structures and the image is not falling on the retina that leads to blurred vision (*Our Obsession with Phones Could Be Changing the Shape of Our Eyes*, 2017). Uncorrected refractive errors are the world's leading reason for vision disability and blindness. It is estimated that 2.3 billion peoples live with this problem (Holden et al., 2000). The World Health Organization has made the remedy of refractive errors one of its key goals in developed and emerging countries, realizing the burden that it can cause and it is easy management (Dandona & Dandona, n.d.). Childhood blindness in Saudi Arabia was often caused by acquired disease or damage prior to 1962, and genetically determined diseases was the mainetiology of blindness since then (Tabbara & Badr, 1985).

Amblyopia and other complications may result from a mistaken or lately corrected refractive error. The incidence of amblyopia in children, adolescents and middle-aged adults has been measured at 1-4 % and is the most prevalent cause of monocular vision disability (Attebo et al., 1998; Department of Health and Human Service, n.d.). Amblyopia causes include strabismus, anisometropia, high refractive errors and opacity of the ocular medium or two or more of these aetiologies in same patient. Visual welfare impacts the achievement of schools, economic productivity and the quality of life in general directly (Hassan Minto, 2011). Amblyopia treatment regimens may include visual correction, patching, atropine, vision therapy, and treatment of the cause in case of sensory deprivation (Alkulaib et al. 2021).

Strabismic eyes are misaligned, and the causes of this condition can be determined. Three of the twelve cranial nerves (III, IV, and VI) may cause a paralyzed or stationary eye. There are several strabismus varieties. Esotropia, Exotropia, Hypotropia and Hypertropia are common forms of strabismus (Sharma et al., 2017). The prevalence of strabismus in children varies worldwide, ranging from 0.14 percent to 5.65 percent. It was linked to assisted delivery, low birth weight, and anticipation (forceps or caesarean section), neurodevelopmental abnormalities, Refractive Errors, Anisometropia, cranial nerve paralysis, maternal age at birth, maternal smoking during childhood, and a family history of strabismus (Azonobi et al., 2009; Oystreck & Lyons, 2012; Pathai et al., 2010; Robaei et al., 2006; Taylor, 2012).

Children detected by primary community screening and secondary screening are then sent to an ophthalmic clinic. As well as children suspected of amblyopia or strabismus can be referred to an eye care centre at any age from general physicians, neighbourhood or hospital paediatricians, health care visitors, nurses and optometrists. There are some referral pathways that leads to ophthalmic services for children with alleged amblyopia or strabismus, although once they arrive, there is a necdotal proof that evaluation strategies and treatment structures vary.

The high risk category for visual disability is considered as school children as uncorrected refractive errors can have a significant impact on their learning capacities and physical and psychological growth. We constructed our study to determine the prevalence of common eye refractive errors among children aged between (3 to 15) years visiting an eye clinic at secondary hospital and evaluate the association with a number of common eye diseases related to refractive errors like strabismus and amblyopia as well as preventable and treatable causes of visual impairment.

2. MATERIALS AND METHODS

A cross-sectional retrospective clinic-based study was conducted from 1st January 2016 to 31st December 2019 in all children aged from 3 to 15 years visiting the Eye OPD at King Khalid General Hospital in Majmaah city. All children underwent a complete eye examination including cycloplegic refraction and dilated fundus examination.

The study protocol and ethical clearance (#20-34 M) was sought from General Directorate for Research and Studies, Ministry of Health (MOH). All procedures were conducted per the Declaration of Helsinki on the use of human subjects in medical research. A prior permission was also taken from King Khalid Majmaah hospital for using the data only for the research purpose.

A detailed history of ophthalmic problems was taken from all children. Examination included uncorrected visual acuity (UCVA), and best corrected visual acuity (BCVA) measured at both far as well as near distance using logMAR Snellen chart at 6 meters (NIDEK Company limited, Japan CHART PROJECTOR CP-770). The absence orpresence of amblyopia was recorded. The cover, uncover and alternate cover test using the eye occluder for distance and near was used to assess heterotopias. Ocular motility and pupillary evaluation in both well-lit and dark conditions was done by using pen torch. Anterior segment examination was done by a slit lamp (CSO- SL9800, Italy). The refractive status of the eye was evaluated using an auto ref-keratometre (NIDEK Company limited, Japan model ARK-1). Dry and wet retinoscopy using 1% cyclopentolate was done by retinoscope KEELER, UK). Dilated fundus examination was done using direct ophthalmoscope. Autorefraction was done by NIDEK Auto-refractokeratometer. The cover, uncover and alternate cover test was used to assess heterotopias.

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The criteria for various outcome measures including normal visual acuity (NVA), amblyopia and strabismus were defined clearly. NVA has been defined as UCVA equal to or better than 0.3 log MAR in the better eye. As for amblyopia without ocular pathology in either eye, it was described as initial BCVA of 0.20 logMAR or worse, and at least two line logMAR differences between the amblyopic and fellow eye. Likewise, diagnosis of strabismus was made as an intermittent or constant horizontal deviation of 10 or more prism dioptre's (DS), a vertical deviation of 3 or more prism DS, or other eye movement disorders. Thus, refractive errors including hypermetropia, myopia and astigmatism were further classified based on severity. Strabismus was classified too by the orientation of squint as explained in (Table 1).

Anisometropia is a condition in which the refractive powers of your eyes differ, causing your eyes to focus unevenly. Asymmetric farsightedness, Asymmetrical curvatures, or asymmetric nearsightedness are all symptoms of this disorder, and develops when one eye is a different size or shape than the other. Antimetropia, a form of anisometropia, is an unusual refractive disorder in which one eye is myopic and another eye is hyperopic. The Inclusion criteria of the study were children from 3 to 15 years with Visual acuity of better than 6/18, in one or both eyes. The exclusion criteria were Blind Children's, Children's with drug allergy to drops.

The data collected were entered by using a computerized proforma, and was entered using an EXCEL (Microsoft Corporation, Redmond, WA., USA 2016) and analysed using Statistical Package for the Social Sciences (IBM SPSS Statistics 2015). Descriptive statistics will be summarized as the mean and standard deviation, median. Shapiro-Wilk test will be performed for testing normality for continuous variables. The data will be expressed using descriptive statistics.

3. RESULTS

The study included 1477 individuals, 686 (46.4%) were males and 791 (53.6%) were females. Most of the children fall in the age between 11-15 years 833 (56.4%) child, followed by 7-10 years 407 (27.6%) and the least was between 3-6 years 237(16%) child. Family history of eye disease was noted in 943 (63.8%) of the children. Table 1 depicts the distribution of patients based on various types of refractive errors in oculus dexter (OD) and oculus sinister (OS). Out of 1477 children enrolled in the study, Astigmatism aligned with/without hypermetropia and myopia was the most frequently occurring refractive error (39.1%- Right eye, 38.4%- Left eye), followed by hypermetropia (28.1%- Right eye, 28.2%- Left eye), Myopia (15.9%- Right eye, 16.2%-left eye), Strabismus in 305 eyes, Esotropia was found in 286 eyes (52.3%), whereas Exotropia in 19 eyes (3.5%).and Amblyopia was found in 242 eyes, with Monocular Amblyopia in 234 eyes (42.8%) and Binocular Amblyopia in 8 eyes (1.5%).

Table 1 The distribution of patients based on various types of Refractive Errors

Refractive Errors		OD		OS		Total	
		N	%	N	%	N	%
Astigmatism	Mild Astigmatism	873	29.5%	882	29.8%	1755	59.3%
	Moderate Astigmatism	265	9 %	236	7.9%	501	16.9%
	High Astigmatism	17	0.6%	19	0.7%	36	1.30%
	Total	1155	39.1%	1137	38.4%	2292	77.5%
Hypermetropia	Mild Hypermetropia	331	11.2%	356	12.0%	687	23.2%
	Moderate Hypermetropia	351	11.9%	345	11.6%	696	23.5%
	High Hypermetropia	149	5.0%	131	4.4%	280	9.4%
	Total	831	28.1%	832	28.2%	1663	56.3%
Myopia	Mild Myopia	307	10.4%	317	10.7%	624	21.1%
	Moderate Myopia	105	3.5%	107	3.6%	212	7.1%
	High Myopia	62	2.0%	54	1.9%	116	3.9%
	Total	474	15.9%	478	16.2%	952	32.1%
Amblyopia	Binocular Amblyopia	4	0.15%	4	0.15%	8	0.3%
	Monocular Amblyopia	149	5.0%	85	2.8%	234	7.8%
	Total	157	5.15%	93	2.95%	242	8.1%
Strabismus	Esotropia	131	4.4%	84	2.8%	215	7.2%
	Exotropia	7	.2%	6	0.2%	13	0.4%

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	Alternating Esotropia	72	2.4%	72	2.4%	144	4.8%
	Alternating Exotropia	5	.2%	6	.2%	11	0.4%
	Total	215	7.2%	168	5.6%	383	12.8%

*Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.

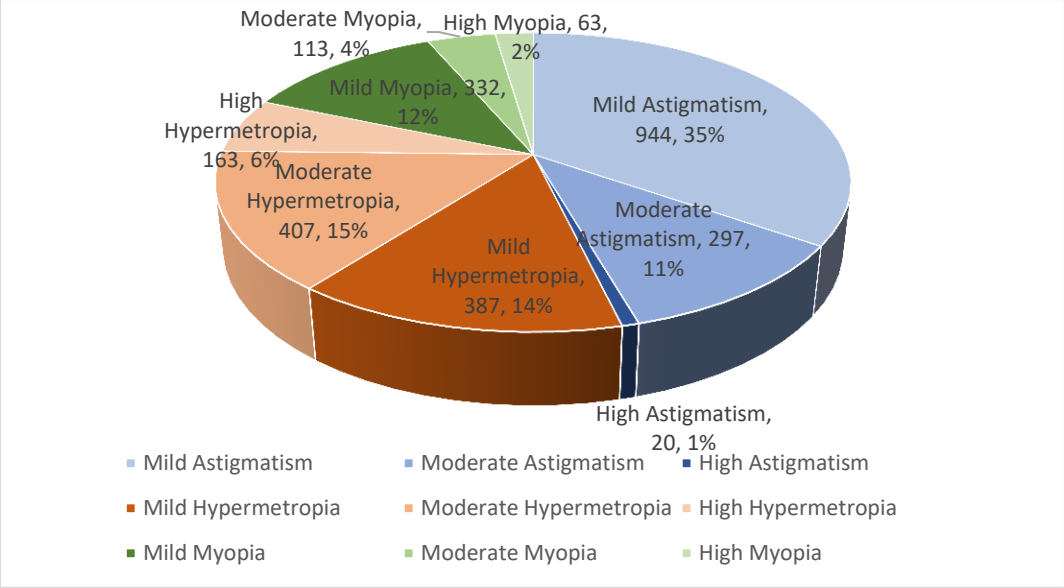

Figure 1 Types and subtypes of refractive errors

Mild astigmatism was noted in most of the individuals either in Right eye (OD) 882 (77.6%) or left eye (OS) 873 (75.6%). Very few had high astigmatism with 1.7% in right eye and 1.5% in left eye. Most of the children had mild or moderate hypermetropia either in right eye or left eye. Significant prevalence of hypermetropia was reported in right eye (15.7%) and left eye (17.9%). With regards to Myopia also being common in children, mild myopia was reported in 317 (66.3%) and 307 (64.8%) in right eye and left eye respectively. About 54 (11.3%) and 62 (13.1%) of children were found to have high myopia in right and left eye respectively (Figure 1). Binocular amblyopia was diagnosed in 8 (1.5%), whereas the monocular amblyopia was found in 234 of children in either eye. The most common reason for strabismus was found to be esotropia in 286 of children either eye (52.3%). Whereas; exotropia leading to strabismus was noted in only 19 (3.5%) (Table 1 & Figure 2).

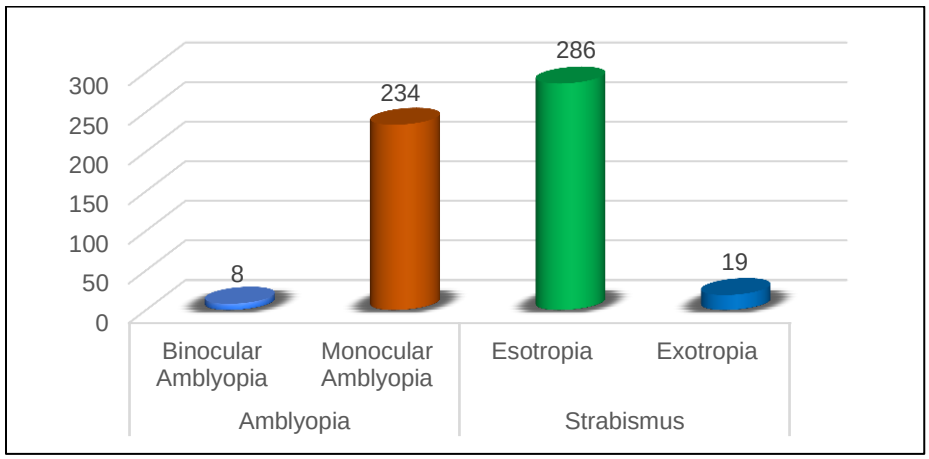

Figure 2 Types of Strabismus and amblyopia

Amblyopia 242 eyes , Monocular Amblyopia in 234 eyes (42.8%), while Binocular Amblyopia in 8 eyes (1.5%), and Strabismus 305 eyes, Esotropia was found in 286 eyes (52.3%), whereas Exotropia in 19 eyes (3.5%). Significant association of refractive errors

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was noted with regards to sex of the child. Astigmatism and Myopia was found to be more common in female children 52.7% and 64.3% respectively, when compared in male children with 47.3% and 35.7% respectively. Hypermetropia, amblyopia and strabismus were noted to be high in males, with hypermetropia (54.1%- males; 45.9%- females), amblyopia (52.2%- males; 47.8%- females) and strabismus (53.7%- males; 46.3%- females). Only 4 cases of antimetropia were diagnosed and all in female children (Table 2). Significant statistical association was found with refractive errors and family history of refractive errors and eye diseases. Majority of children with astigmatism (68%) had positive family history of eye disease, followed by Myopia (81%), amblyopia (68.2%), strabismus (64.5%) and hypermetropia (53.3%). Almost all the children with Antimetropia reported to have family history (Table 2).

Table 2 Comparison of Refractive Error between males and females, Distribution of patients with refractive errors based on family and relation with Amblyopia and Strabismus

Error	Family history of Refractive Errors				Sex				Amblyopia				Strabismus			
	Yes	No	Total	Chi-Square, P-value	Male	Female	Total	Chi-Square, P-value	No	Yes	Total	Chi-Square, P-value	No	Yes	Total	Chi-Square, P-value
Astigmatism	794 (48.6%)	373 (43.7%)	1167 (46.9%)		552 (46.9%)	615 (46.9%)	1167 (46.9%)		982 (47.7%)	185 (43.3%)	1167 (46.9%)		954 (48.4%)	213 (41.3%)	1167 (46.9%)	
Hypermetropia	444 (27.2%)	389 (45.6%)	833 (33.5%)		451 (38.3%)	382 (29.2%)	833 (33.5%)		617 (30.0%)	216 (50.6%)	833 (33.5%)		539 (27.3%)	294 (57.0%)	833 (33.5%)	
Myopia	395 (24.2%)	92 (10.8%)	487 (19.6%)	110.904, <0.001	174 (14.8%)	313 (23.9%)	487 (19.6%)	41.796, <0.001	461 (22.4%)	26 (6.1%)	487 (19.6%)	94.309, <0.001	478 (24.3%)	9 (1.7%)	487 (19.6%)	217.407, <0.001
Total	1633 (0.0%)	854 (0.0%)	2487 (0.0%)		1177 (0.0%)	1310 (0.0%)	2487 (0.0%)		2060 (0.0%)	427 (0.0%)	2487 (0.0%)		1971 (0.0%)	516 (0.0%)	2487 (0.0%)	

4. DISCUSSION

Visual impairment Secondary to uncorrected refractive error, such as lack of opportunity for schooling and jobs, barriers to economic development for people, communities and populations and reduced or diminished quality of life may have serious or long-term repercussions (William, 2006). Various reasons add to the uncorrected refractive errors: lack of knowledge and acceptance on the issue at personal and family level; failure to make refractive facilities available and/or incapable of being provided; inadequate provision of affordable correction lenses; and disincentives to cultural conformity. Public health concerns the prevalence of refractive and visual defect secondary to uncorrected refractive error (Dandona & Dandona, n.d.; Resnikoff et al., 2008).

This cross sectional retrospective study included 1477 individuals with 686 (46.4%) males and 791 (53.6%) females. Most of the children was aged between 11-15 years 833 (56.4%) followed by 7-10 years with 407 (27.6%) individuals. Family history of eye disease was noted in 943 (63.8%) of the children. Similar observations were reported in Lisa A. Jones et al., (2007) study showed that 111 (21.6%) of the 514 children who were eligible for this study developed myopia. The number of myopic parents (P 0.001) and the number of sports and outdoor activity hours per week (11.65 6.97 hours for nonmyopes vs. 7.98 6.54 hours for potential myopes, P 0.001) were found to be different in the third grade between eventual myopes and nonmyopes (Jones et al., 2007; Landers et al., 2010).

In this study we reported astigmatism the most common refractive error (40.8%- Right eye, 42%- Left eye), followed by hypermetropia (29.4%- Right eye, 30.6%- Left eye), Myopia (14.7%- Right eye, 17.7%; left eye- 171.7%), strabismus (7.5%- Right eye; 6.2%- left eye) and amblyopia (5.6%- Right eye; Left eye 3.4%). Comparing our observation to other similar study conducted by Saw et al., (2002) reported prevalence rate of myopia was 26.1%, hyperopia was 9.2%, astigmatism 18.5% and anisometropia 15.1%. Similar observation were reported by Flitcroft (2014) in his study Emmetropisation and the aetiology of refractive errors showed the most common refractive error at age of 6 years is hyperopia with both anisometropia and myopia being far less occurring error at this age. Since the prevalence of myopia shows a marked increase in later years, only a very small proportion of myopic refractive errors can be attributed to a primary failure of emmetropisation and other study results showed myopia, astigmatism, and hyperopia in 131 (21.62%), 56 (9.24%), and 5 (0.83%) children, respectively where eye deviation was found in six children (1.65%), all of which showed extropia (100%). Eye deviation ensued together with myopia in a child (17%), and with astigmatism in three children (50%). Two more children (33%) had other conditions such as amblyopia. Eye deviation is most frequently seen in

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astigmatism. For refractive errors, myopia is the most frequently error while hypermetropia is the least common (Flitcroft, 2014; Vafidis, 2005; Zhu et al., 2015).

There was a strong connection between the different forms of refractive error 82% of the total cases with spherical refractive error had mild to moderate myopia, while the majority had hyperopia or extreme myopia. The majority of the cases with cylindrical refractive error had mild to moderate astigmatism, with 85% having severe to extreme astigmatism and 47 having severe to extreme astigmatism (Ahmad & Alabdulwahhab, 2021). In similar previous studies were reported higher incidence of strabismus compare to our study in Turkey (2.4%; 6 to 14 years) (Caca et al., 2013), Japan (1.3%; 6 to 12 years) (Matsuo & Matsuo, 2005) and the Refractive errors study in children's studies (5 to 15 years) which reported the prevalence of strabismus of 1.9% in southern China (He et al., 2004) , 1.3% in South Africa (Naidoo et al., 2003), 1.9% in India (Dandona et al., 2002), 0.53% in New Delhi (Murthy et al., 2002), 2.3% in Chile (Maul et al., 2000), and 2.1% in Nepal (Pokharel et al., 2000).

Previous studies in Iran and Australia have reported amblyopia in 23% and 37% of squint patients, respectively (Rajavi et al., 2015; Robaei et al., 2006). The high prevalence of amblyopia in patients with strabismus observed in our study has been explained by inadequate compliance with social stigmatic glass wears and only 38 % of the cases of amblyopia with the occlusion therapy. In Asians (Singapore, China, Singapore, Malaysia and Indonesia), the incidence of myopia is evidently higher and can be shown to have genetic propensity for myopia (Wu et al., 2001). We reported in this study , the most common reason for strabismus to be esotropia (50%- right eye, 60.9%- left eye), followed by alternating esotropia (42.9%- Right eye, 33.5%- left eye). Whereas; exotropia leads to strabismus was noted in only 6 (3.6%) in right eye and 7 (3.3%) in left eye. These results are consistent with the results from other studies that have identified a close link between mild and amblyopic hyperopic refraction (Ingram et al., 1986; Robaei et al., 2006; Sjöstrand & Abrahamsson, 1990).

This study was cross sectional retrospective which was the main limitation of this study. Regular advertising programs on childhood vision issues and the importance of early diagnosis and management should be held at various locations like classrooms, shopping malls and social media, including screening examinations where possible.

5. CONCLUSION

The causes associated with childhood strabismus were considerably due to the prevalence of amblyopia, clinically important refractive errors, age and family history. Early screening is also necessary for infant strabismus. Most children who were visually disabled did not have shown, which indicate that there is an important demand for RE programs. Early diagnosis and treatment of refractive defects, strabismus and amblyopia, reduce the occurrence of strabismus and amblyopia in children and improving their quality of life and education.

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Author Contributions

Conceptualization: Rashed Almutairi and Khalid M Alabdulwahhab; Methodology: Rashed Almutairi, Dr Mohammad Shakil Ahmad; software: Riyaz Ahamed Shaik; validation: Khalid M Alabdulwahhab, Mohammad Shakil Ahmad, and Riyaz Ahamed Shaik; formal analysis: Riyaz Ahamed Shaik; investigation: Rashed Almutairi. Mohammad Shakil Ahmad; resources: Mohammad Shakil Ahmad; data curation: Riyaz Ahamed Shaik; writing—original draft preparation: Khalid M Alabdulwahhab, Mohammad Shakil Ahmad, Riyaz Ahamed Shaik; writing—review and editing: Rashed Almutairi, Mohammad Shakil Ahmad; visualization: Riyaz Ahamed Shaik and Mohammad Shakil Ahmad; supervision: Khalid M Alabdulwahhab and Mohammad Shakil Ahmad; project administration: Mohammad Shakil Ahmad

Ethical approval

The study was approved by the Medical Ethics Committee, General Directorate for Research and Studies, Ministry of Health (MOH) with ethical approval code #20-34 M.

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Conflict of Interest

There are no conflicts of interest.

Data and materials availability

All data associated with this study are present in the paper.

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