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Screening for Musculoskeletal Deviations: Epidemiology and Patterns of Occurrence among Basic School Pupils in Accra Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author AIB conceptualized the project, drafted the manuscripts, collected and analyzed the data. Author AH participated in the data collection, coded and analyzed participants response. Author JA participated in manuscript formatting and editing. Author SO assisted in literature search and review. Author BS edited and aligned the manuscript. All the authors read and approved the final manuscript.

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ABSTRACT

Background: Childhood age through adolescence mark period of major postural transformation which warrants screening for structural abnormalities. The study provided needs assessment for musculoskeletal screening and determined the prevalence of musculoskeletal deviations (MSDs) among pupils in Junior High Schools.
Methods: An all-inclusive qualitative musculoskeletal screening exercise was conducted in eight private and public basic schools within Accra Metropolis. The schools were sampled through multi-staged sampling technique from a cluster of 264 schools. After due permissions from the Ghana Education Service Directorate, Head Teachers and parents, pupils were screened for various MSDs. Screening procedures largely involved manual testing, observation and measurements

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using paediatric Gait, Arms, Legs and Spine (pGALS) as a guide. Data were gleaned to descriptive and inferential analysis at 95% CI.

Results: A total of 1,532 pupils (mean age: 14.6±1.7 years) were screened. They comprised 696 (45.3%) males. The pattern of MSDs indicate Hallux valgus as the most presented MSDs, 475 (31%) and 242 (15.8%) of them were females. Elevated scapular was the least as found among 21 (1.3%) pupils. There were significant differences ($p<0.05$) in the frequency of male and female pupils with clawed toes, genu valgus, winged scapular, kyphosis, scoliosis and cubital valgus. Two Hundred and Fifty-Four (16.6%) of the total sampled pupils presented with two or more MSDs.

Conclusion: The outcome of the screening revealed high prevalence of MSDs among the sampled pupils with females being more predisposed than their male counterparts. The finding has provided cue for initiating musculoskeletal screening among Ghanaian children in basic schools.

Keywords: Prevalence; musculoskeletal deviations; epidemiology; socioeconomic factors.

1. BACKGROUND

Musculoskeletal deviations (MSDs) are the distortions of musculoskeletal system from the normal alignment which may preset a system of imbalance, or abnormal strain [1]. The author reported that the imbalances commonly observed in musculoskeletal system were causally implicated in the incidence of musculoskeletal disorders such as deformities, injury and/or pain. Indeed, several studies have lent credence to a possible association between musculoskeletal pain and injury in childhood and development of musculoskeletal disorders in adults [2]. The cited studies on this subject premised their arguments on the intrinsic and extrinsic factors that can influence human growth such as heredity, the environment or physical conditions in which the subject lives, socioeconomic level, emotional factors, and physiologic alterations due to human growth and development [3,4]. The major transformations of human posture are said to occur at the prepuberal phase and puberty periods of life (between 7 and 12 years of age) during which the posture undergoes many adjustments and adaptations due to changes in the body and other psychosocial factors [4]. This submission underscores the relevance of early screening exercise for MSDs among adolescents.

Certified healthcare professionals in this field often take advantage of the physiological process to diagnose any postural deviations not only because the child is prone to alteration of the bone system but also because poor bone formation and poor posture are more easily amenable to correction at this stage of development [4,5]. Most commonly, children adopt improper postures at home and at school which can cause an imbalance in their body segments thus resulting in postural alterations [6]. It thus presupposes that vigilance by parents and teachers is very important for the timely correction of postural deviations so as to avoid permanent deformities. Already, congenital and acquired deformities of the musculoskeletal system account for more than 20% of patient visits to primary care and emergency medical practitioners in the US [7,8]. In Africa and developing countries, the harmful effects of musculoskeletal disorders may have more health impact owing to poverty with its attendant malnutrition, infectious diseases, ignorance, and inadequate medical facilities [9,10]. These observations offer opportunity for routine screening exercise to identify MSDs during the childhood so as to curtail its possible progression to adulthood.

In the developed countries, school postural screening programme has been an established policy which is meant to facilitate early identification and prompt intervention in the event of any musculoskeletal abnormalities [3,4,11,12]. In Ghana, health screening among school going adolescents is yet to be adopted as policy in the education system. Studies investigating musculoskeletal deviations among school age children are scarce for referencing in literature. In addition, although several studies have reported the outcome of spinal screening programme for pupils and students, [6,13] very few have considered other body segments within musculoskeletal system. Given the anatomical interconnectivity in human body and the potential differential influence over one and other, solitary examination of the spine for its effects on bodily function may not suffice to identify the individuals with MSDs. This view adds value to the need to consider the holistic assessment of musculoskeletal system.

The present study was therefore designed to determine the prevalence of MSDs among Junior High School (JHS) pupils. This was meant to

establish the necessity for health screening programme as part of routine requisite formalities at basic schools.

2. MATERIALS AND METHODS

2.1 Study Sites

The study was conducted at selected JHS in the Accra Metropolis which forms part of the Greater Accra Region of Ghana. Junior High School is part of Ghana's basic education programme nation-wide and it began in September 1987 across all Districts of the Regions in the country. There are Two Hundred and Sixty Four (264) JHS in the Metropolis that are divided into 10 circuits of private and public schools.

2.2 Procedure

Ethical approval for this study was sought and obtained from the Ethical and Protocol Review Committee of the University of Ghana Medical School. Ghana Education Service Directorate gave approval to screen the pupils upon Researchers' request. Subsequent permission was obtained from the school heads who in turn notified the parents and guardians. During the 2013/2014 academic session, all the children whose parents/guardians agreed to the screening exercises were assessed. Schedules of visit per day with regard to the time were discussed with the school heads so as not to interfere with the school routines

2.3 Participants

Participants for this study were male and female JHS pupils within the age range 10 to 20 years. All the pupils attending the selected basic schools were eligible to participate in the screening programme. The sample size was determined using Armittage and Perry formula {n=p (1-p) z 2 /d 2} of single proportion, where n is the minimum sample size required, p is the prevalence of MSDs among Ghanaian JHS pupils estimated at 50% based on previous preliminary data on the prevalence of scoliosis among adolescents in the Metropolis, z is the standard normal deviation set at 1.96 which corresponds to 95% confidence interval, and d, the degree of accuracy estimated at 4%. Therefore, a projected minimum sample size of 600 pupils was made.

2.4 Sampling of the Schools

Schools were selected using multistage sampling methods. The first stage involved eliminating all single-sex schools from the list of schools obtained from the Ghana Education Service. The second stage involved grouping the remaining schools into 10 circuits of schools under Accra Metropolis. In the third phase equal numbers of public and private schools were selected through proportional quota sampling from each circuit. The fourth stage involved selection by simple random technique without replacement to arrive at 10 public and 10 private schools. The final stage involved selection of five schools each from the public and private schools through systematic sampling technique. Incidentally, two of the selected ten schools evolving from the last step, had less than 100 pupils in total thus leading to their elimination. So, four schools each from the private and public schools were eventually selected for the study and all the pupils in these schools were enrolled into the study.

2.5 Materials for Data Collection

2.5.1 Measuring instruments

Mercury operated scoliometer (Netherlands) calibrated in degree was used to screen spinal deformities. The measurements of the alignment of the lower and upper extremities were determined with double arm goniometer and tape measures. Endorsing ink, foot pad, plain white A-4 sheets and meter rule were used for pupils' footprint analysis. Data capturing form was used to obtain information about their parents regarding their age, sex, education level as well as parental and employment status.

2.6 Screening Protocols

The qualitative screening exercise covered a period of 12 months, and it was carried out by the lead researcher (with profound orthopaedic background) and three other Physiotherapists together with 4 Research Assistants. Musculoskeletal examination form was designed in which various MSDs were outlined sequentially. Designations of the student's sex, school and the identification number were noted on the form. Most assessments comprised observation, palpation, movement, special tests and measurements. Each of the MSDs was measured and quantified through a standardized protocol as outlined in paediatric Gait, Arms, Legs and Spine (pGALS) which is an evidence-based approach to basic paediatrics musculoskeletal assessment [14]. pGALS has been shown to be equally effective for adult and adolescents [15].

The sequence of look, feel and move was adhered to whilst the scores were compared to the existing normative values/tests where such were necessary. Female participants were required to dress in physical education clothing (shorts and shirts) and their male counterparts did not necessarily wear shirt. In most cases, female pupils were examined by an experienced female co-principal investigator to ensure ethics norms. Procedure commenced with visual (initial) inspection whereby participants in erect standing were examined anteriorly and posteriorly and from the trunk to the lower extremities as follows:

2.6.1 Spinal assessment

In double stance, participants were examined to screen for asymmetry of the shoulders (elevated scapular), rib cage or hips; prominent scapula (winged scapular), lateral spinal curve (scoliosis), lordosis, apparent rib hump (kyphosis) torticollis and protruding abdomen. Forward-bend position (Adam's position) was demonstrated to the participants. They were asked to perform the movement whilst the PI stands behind with his eyes leveled to participant's back to look at his trunk for any spinal deviation on the spine. Final spinal assessment involved ascertaining the presence of scoliosis and kyphosis with scoliometer by placing the device at the site of the deformity. A score of 10^{o} as indicated in the scoliometer, defined positive screening [6].

2.6.2 Lower extremity assessment

Inspection was performed from the frontal and sagittal planes in lying, standing and during walking to identify the presence of genu varum, genu valgum, cavus foot, hallux valgus, bunion, forefoot varus, pronation and tibia torsion. Final screening involved analysis of weight-bearing static Foot Instep Width to screen for pes planus and pes cavus. An instep width < 1cm indicates presence of pes planus whilst mid foot print < 1cm (pes cavus) [16]. Cleaning materials: comprise water, soap, methylated spirit and towel which were used to clean pupils' feet after footprints performance. Genu valgum and genu varum were quantified by measuring the inter malleoli and inter pattella distances respectively (inter-patella distance >15 cm indicates genu varum while inter-malleoli distance >12 cm defined genu valgum. Limb length discrepancy was ascertained with tape measure by measuring the distance between the anterior superior iliac spine and medial malleolus of each limb and the difference compared. Feet were also observed for Hallux valgus and forefoot varus in this position.

2.6.3 Upper extremity assessment

In standing position, participants' upper limbs were screened for deviation or deformity including trigger finger, winged scapular, cubital vagus and varus deformities. Participants who are found to show any deviation were made to undergo the final screening almost immediately. Winged scapular was assessed by asking the participants to push against the wall while the examiner stands behind to observe any excessive protrusion. The assessment of cubital valgus and cubital varus was performed in standing with the affected arm supinated. The angle between the shaft of humerus and ulna was measured with goniometer.

Pupils who were found to have two or more of the MSDs were identified and the school heads and teachers were briefed about the outcome of the screening for onward communication with parents and guardians. The choice of pupils with only two or more MSDs for further evaluation was premised on the assumption that there are possibilities that most postural deviations identified at this stage may correct its self later in life aside from the structural abnormalities [3].

2.7 Data Analysis

The categorical data were analyzed using SPSS version 20, using descriptive statistics such as means, standard deviation, frequencies and percentages. Other independent variable such as sex with respect to the incidence of MSDs and its frequency was assessed using Odd Ratio and Chi-square tests. The probability level of statistical significance was set at 0.05 alpha values.

3. RESULTS

3.1 Socio-demographic Profiles

A total of 1,532 pupils of age range 10 to 20 years (mean age= 14.6±1.7 years) were screened comprising 696 (45.3%) males and 836 (54.4%) females. Seven Hundred and Fifty-Three (49.2%) of the pupils were attending private JHS compared with their peers, 779 (50.8%) in public schools. Majority of the pupils 151 (59.4) had double parents status as against 39 (15.4%) who were under guardians. Fifty-Two (20.6%) of the pupils stated that their parents had no formal

education but 48 (19.0%) parent/guardians had tertiary education. One Hundred and Forty (55.6%) of the pupils' parents were self-employed compared to 27 (10.7%) who were not employed and 3 (1.2%) who were pensioners. Results are presented in Table 1.

Of all the MSDs identified, hallux valgus was found most among 475 (31%) of the pupils and 242 (15.8%) of them were females followed by pes planus (In step width <1cm) which was identified among 123 (8%) of the pupils. In addition, 97 (6.3%) of them had developing pes planus (In step width range, 1-3 cm). High prevalence of MSDs were found in the following patterns Halux valgus 475(31%), Cubital valgus 247(16.1%) winged scapular 127(8.2%) and pes planus 123(8.0%). Elevated scapular was the least MSDs which was found among 21(1.3%) pupils of which 8 (0.5%) were females (Table 2). There were significant differences in the number of male and female pupils with clawed toes (p=0.016), Genu valgus (p=0.001), winged scapular (p=0.001), kyphosis (p=0.031), scoliosis (p=0.001) and cubital valgus (p=0.001). The prevalence of genu valgum (OR=0.26; 95% CI=0.13-0.486), winged scapular (OR=0.297; 95% CI= 0.184-0.465), kyphosis (OR=0.699; 95% CI= 0.408-1.175), scoliosis (OR=0.389; 95% CI= 0.189-0.752), and cubital valgus (OR=0.327; 95% CI= 0.236-0.45) were significantly greater in female than in the male pupils. However, the odds of the prevalence based on gender influence for these deviations is low (OR<1). Whereas, gender influence on the odds of prevalence for developing pes planus and clawed toe is high in favour of the male pupils. Results are presented in Table 3.

Table 1. Socio-demographic status of the pupils' parents

Variables	Response	N	%
Which of the following best describes your parental status	Single parent	64	25.2
	Double parent	151	59.4
	Guardian	39	15.4
What level of education did your parent attain	Not educated	52	20.6
	Primary	33	13.1
	JHS	67	26.6
	SHS	52	20.6
	Tertiary	48	19.0
What type of job do your parents do?	Government-employed	46	18.3
	Self-employed	140	55.6
	Private-employed	36	14.3
	Pensioners	3	1.2

Table 2. Prevalence of musculoskeletal deviations by gender

MSDs	Male		Female		Total	
	n	%	n	%	N	%
Pes planus	55	3.6	68	4.4	123	8.0
Pes planus (developing)	55	3.6	42	2.7	97	6.3
Clawed toes	24	1.6	10	0.6	34	2.2
Halux vagus	233	15.2	242	15.8	475	31
Genu valgus	13	8.4	57	3.7	70	4.5
Genu varus	23	1.5	24	1.6	47	3.1
Genu recurvatum	29	1.9	28	1.8	57	3.7
Winged scapular	27	1.8	100	6.5	127	8.2
Elevated scapular	8	0.5	13	0.8	21	1.3
Kyphosis	26	1.7	44	2.8	70	4.5
Lordosis	29	1.9	30	1.9	59	3.8
Scoliosis	13	0.8	39	2.5	52	3.3
Cubital valgus	60	3.9	187	12.2	247	16.1

N.B. The percentage distribution is with reference to the total number of the pupils i.e. N=1,532 pupils

Table 3. Comparison of the prevalence of MSDs between male and female pupils

Deformities	Male	Female	OR	95% CI of OR		df	χ2	p
Pes planus	55	65	0.973	0.659	1.432	1	0.02	0.8843
Pes planus dev.	55	42	1.622	1.05	2.518	1	5.31	0.0213
Clawed toes	24	10	2.95	1.347	6.957	1	8.88	0.0029
Halux Valgus	233	242	1.235	0.988	1.544	1	3.64	0.0563
Genu valgus	13	57	0.26	0.13	0.486	1	21.35	<0.001*
Genu varus	23	24	1.156	0.617	2.16	1	0.24	0.624
Genu recurvatum	29	28	1.255	0.712	2.212	1	0.71	0.4
Winged scapular	27	100	0.297	0.184	0.465	1	32.63	<0.001*
Elevated scapular	8	13	0.736	0.263	1.929	1	0.46	0.4966
Kyphosis	26	44	0.699	0.408	1.175	1	2.03	0.154
Lordosis	29	30	1.168	0.669	2.035	1	0.34	0.5582
Scoliosis	13	39	0.389	0.189	0.752	1	9.06	0.0026
Cubital valgus	60	187	0.327	0.236	0.45	1	53.08	<0.001*

*Key: * Significant*

4. DISCUSSION

The epidemiologic study was designed to determine the prevalence of MSDs among the school going adolescents in Ghana as a needs assessment for such routine exercise in basic schools. Of the total twelve MSDs screened, our findings indicate high prevalence of hallux valgus, cubital valgus, winged scapular and pes planus among the sampled pupils. In addition, female pupils seem to be more disposed to the deviations than their male counterparts. Previous studies on this topic alluded to these findings [3,4,11]. The present finding has supported the existing view that there is high prevalence of MSDs among the school going adolescents and this has further stressed the need for implementing preventive measures in the form of prompt detection through routine screening among this age group.

Although it is difficult to get studies depicting this spectrum of MSDs for comparison in developing African countries, Penha et al. [3] reported high prevalence of musculoskeletal deviations among a cohort of Brazillian School going girls, aged between 7 and 10 years. However, some of the identified deviations were reported to reflect normal postural development, which were expected to naturally correct during the children's growth. In the present study, hallux valgus and cubital valgus were the most presented MSDs with incidence of 31% and 16.1% respectively whilst elevated scapular is the least (1.3%). These findings were at variance with report of Francis and Brice whose study indicated lordosis as the most presented MSDs, [11] and Penha et al. [3] who reported medial rotation of the hip and valgus ankle as the most common deviations.

Even though there are slight variations in the methodological approach adopted by all the authors to execute the screening programme, the aetiological antecedents of MSDs have been broadly ascribed to intrinsic and extrinsic factors namely; heredity, the environment or physical conditions in which the subject lives, socioeconomic level, emotional factors, and physiologic alterations due to human growth and development [4]. These determinants may have played out in the varying outcomes between the previous and the present studies. Biomechanically, it has been reported that improper postures adopted by children at home and at school cause body musculature imbalances that result in postural abnormalities which may last throughout adult life if not corrected and cause painful syndromes [17]. In Ghana for instance, there is preponderance for fairly used footwear which are commonly worn by school children owing to its affordability irrespective of any biomechanical deficits that may characterize its use. The habit could give rise to deviation of the toes particularly the hallux, which probably might have caused high incidence of hallux valgus.

Of equally significant finding in this study is the higher prevalence of genu valgum, winged scapular, kyphosis, scoliosis and cubital valgus in the female pupils than their male counterparts. Granted that different deviations were reported by the previous authors, the outcome of the comparison of MSDs on gender basis seems to be divergent. This clearly indicates that there are gender-specific abnormalities which may be related to muscle, skeletal and flexibility differences that underline the postural patterns of the individual during growth [4]. Some discrete

physiological processes of body structure have been ascribed to this event. For instance, higher prevalence of musculoskeletal disorders in females is attributed to the presence of more type-one fibers in the trapezius as well as sexual dimorphism of the spine in the former [18]. Also, gender differences in postural response and orthostatic balance relating to gender, spinal development level, muscle recruitment and skeletal maturity have been previously implicated in which females have better orthostatic equilibrium than men [19].

Poor management of MSDs or lack of it is often compounded by late diagnosis on one hand and low awareness about healthcare on the other. 20.6% of the parents or guardians of the sampled pupils were not educated which should not be underrated as risk factors with respect to their low vigilance on any possible postural deviation presented by their wards. Ensor and Cooper had previously stressed the likely impact of maternal education on healthcare seeking and utilization which might have reflected in this study [15]. In addition, the impact of socio-economic factors cannot be overlooked as 55.6% of the parent/guardians of the pupils were self-employed which may limit their financial capacity for seeking healthcare service. More so, no emergency care is often attached to MSDs.

Albeit, the impact of the present findings were not tested on the existing health and education policies in Ghana, it nonetheless suggests necessity for periodic screening in our basic schools so as to formulate effective preventive strategies through health surveillance on the possible progression to older age. Such measure could lead to drastic reduction in healthcare costs for both individuals and countries at large. It is therefore not out of place to advocate policy option in which school health screening form part of routine exercise in the basic schools right from the admission year.

5. CONCLUSION

Within the confinement of limitations of this study therefore, it can be deduced from the outcome that the prevalence of musculoskeletal deviations was high among the pupils in Junior High Schools within Accra Metropolis of Ghana which necessitates adequate screening programme to prevent any possible progression to older age. Gender specific MSDs were also discovered among the adolescent which tends to show preference for the female group in this study. This information could therefore become useful to healthcare educators as a means of devising strategies during postural education. The study has also provided an insight into the likely influence of the parents' socio-economic impact on health concern of their wards.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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