ORIGINAL ARTICLE

Associated Factors of Growth With the Prevalence of Adolescent Idiopathic Scoliosis Among Female Primary School Children in Kuala Langat

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ABSTRACT

Introduction: Scoliosis is a deformity of the spine that presents with a 'S' or 'C' curve with the most common type called Adolescent Idiopathic Scoliosis (AIS). The deformity begins unnoticed and can rapidly progress into severe deformation during the adolescent's growth spurt. Factors such as onset of puberty, dietary intake, physical activity and ethnicity contributes to the development of AIS. Therefore, this study aims to determine the association of these factors with the prevalence of AIS among female school children in Kuala Langat. **Methods:** A total of 374 students between age 10 and 12 from six different primary schools in Kuala Langat were recruited according to the inclusion criteria. Consent form and questionnaire was distributed to the student's parents/guardian prior conducting the research. Adam's Forward Bend Test was performed to measure the rotation of the trunk using a smartphone Scoliometer Application. **Results**:Out of 374 students, 21 students from schools in Kuala Langat were found positive for AIS with a prevalence rate of 5.6%. However, no association was seen between the student's age of menarche, dairy intake, frequency in physical activity and ethnicity with the prevalence of AIS. **Conclusion**: The factors measured in this study showed no association with the prevalence of AIS among school children in Kuala Langat.
Keywords: : Adolescent idiopathic scoliosis, Menarche, Physical activity, Dairy intake, Ethnicity

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INTRODUCTION

Scoliosis is a type of bone deformation of the spine that forms an abnormal lateral curvature at the thoracic and lumbar region (1). The most common type of scoliosis is called Adolescent Idiopathic Scoliosis (AIS). It affects 0.4-7% of Asian population and females are eight times more predisposed as compared to males (2). Although the cause is idiopathic, studies showed that AIS begins during an adolescent's growth spurt where an intense and rapid increase in the rate of growth in height and weight occurs (3, 4). This transitional stage from childhood to puberty begins at an average of 10 years old in girls and 12 for boys (1).

Over the years, the adolescent's growth spurt has been associated with factors such as the onset of puberty, calcium intake, physical activity and ethnicity (5-7). Together, these factors interplay to achieve normal development of vertebral column upon completion of pubertal growth. Dysregulation of these factors may lead to asymmetrical growth of the vertebrae. The vertebrae become wedged causing the spinal column to curve as it grows (8).

A female's maturity depends on the expression of sex hormones such as estrogen and androgens that peaks at their age of menarche (5). These hormones also play an important role in growth, maturation and maintenance of bone. Delay in the age of menarche may affect an adolescent's growth potential and lead to the development of AIS (7). This was proven when scoliosis screening performed in primary schools showed a 2% prevalence rate of AIS among 12-year-old female students and 2.55% in age between 13 and 15 years old (9). These students were documented to have delayed menarche with much progressed curve.

At puberty, adequate amount of dietary calcium and

vitamin D is required to sustain the remaining skeletal growth (10). Calcium intake is necessary for normal bone mineralization particularly during rapid bone growth at puberty. Studies have shown AIS adolescents with insufficient calcium intake was associated with low bone mass density (BMD) and abnormal vertebral mineralization (11, 12). Low BMD in AIS females were reported to have 20% risk of developing osteoporosis and osteopenia later in life (13). During pubertal growth, regular physical activity helps to maintain normal BMD (14). The mechanical load generated during physical activity promotes vertical growth at the epiphyseal plates and prevents wedging of the vertebrae (15).

Furthermore studies are also showing that ethnicity influences AIS prevalence rate (7). A study conducted in Singapore showed AIS prevalence rate was higher among Chinese (3.5%) as compared to Malays (1.7%) and Indians (1.7%) (16). AIS can affect all races however the prevalence rate may not be the same in all racial groups. This is because the genetic variation from each ethnicity decides the disease severity (7). Therefore, this study aims to associate the markers related during growth spurt such as (i) age at menarche, (ii) dairy intake, (iii) physical activity and (iv) ethnicity with the prevalence of AIS among female primary school children.

MATERIALS AND METHODS

Ethics

The ethics approval for this research was obtained from UiTM Research Ethics Committee (Reference no: REC/402/18). Permission to conduct this research in schools was granted by the Selangor Ministry of Education (Reference no: KPM.600-3/2/3-eras (2690)) and District Education Office (PPD) of Kuala Langat (Reference no: PPDKL.PDP 100-4/1JLD 14). Consent to conduct screening during physical education (PE) lesson was obtained from the school's headmaster/ headmistress.

Data Collection Procedure

This was a cross-sectional screening study that was conducted among female primary school students between age 10 and 12 years old from six primary schools in Kuala Langat District: (i) Sekolah Kebangsaan Sri Langat, (ii) Sekolah Kebangsaan Batu Laut, (iii) Sekolah Kebangsaan Tanjung Sepat, (iv) Sekolah Jenis Kebangsaan (C) Kah Wah, (v) Sekolah Jenis Kebangsaan (T) Pusat Telok Datok and (vi) Sekolah Jenis Kebangsaan (T) Simpang Morib.

This study included healthy female students between the age of 10 and 12 that was given consent by their parents or guardian. Students diagnosed with spine deformity, have undergone spine surgery, fail to complete or return the questionnaire and was absent on physical examination day was excluded from this study.

Sample Size Calculation

Convenience sampling was used in this study and the sample size was calculated based on the following formula (17).

$$n = Z^2 P(1-P)/d^2$$

Where,

n = sample size,
Z = level of confidence,
P = expected prevalence
d = precision.

The confidence interval (CI) for this study is 95% CI which makes the confidence level (Z value) equal to 1.96 (17). Because the prevalence rate (P value) of this study is less than 10%, the precision (d) value is half of the P value. Therefore, the expected prevalence rate of this study is 2.55% (18) and was converted to a whole number and rounded off.

Therefore,
P value is 2.55% is changed to a whole number
P value = 2.55/100 = 0.0255
Upon rounding off the figure, the value becomes 0.0331.
Meanwhile, d value is half of P value which gave 0.015.

The sample size was calculated as follow:

$n = Z^2 P(1-P)/d^2$
$=1.962\ (0.03)\ (1-0.03) / 0.0152$
$= (3.8416)\ (0.03)\ (0.97) / 0.000225$
$= 0.11179056 / 0.000225$
$= 496.84693333$

With the consideration of 20% dropout, the total sample size was 596.

Instruments

A questionnaire consisting of four section was constructed from three different validated questionnaires which was related to factors contributing to AIS. In section one, demographic information of the student such as name, age, sex, race, name of school, parents/guardian income and contact number was asked. In section two, secondary sex characteristics was asked followed by section three where back pain and frequency of physical activity was asked. Finally in section four, diary intake and its frequency were asked. The questionnaire was answered by parents/guardians. Physical examination was carried out by a physiotherapy research student accompanied by a teacher.

Tanner Scale Questionnaire

In section two, tanner scale was used to assess physical development of secondary sex characteristics of the female students (19). It grades the growth of pubic and underarm hair, presence of acne and their age of menarche. This questionnaire was validated in a study consisting of 178 adolescents. The adolescent's assessment was validated against a physician which

suggested predictive and discriminate validity of self-assessments. (20)

Back Pain and Body Postural Evaluation Instrument (BackPEI) Questionnaire

In section three, Back Pain Body Posture Evaluation Instrument (BackPEI) questionnaire was used to assess back pain and related risk factors related to the spine in primary school children (21). It includes questions related to physical activity and its frequency, hours spent on the computer, television and sleeping. The questionnaire validity was checked by eight experts and the reproducibility was tested by applying the questionnaire to 260 primary schoolchildren (21).

Food Frequency Questionnaire (FFQ)

In the last section, Food Frequency Questionnaire (FFQ) was used to assess habitual dietary intake of an adolescent (22). In this section, questions related to types of dairy intake, its preparation and frequency was measured. This questionnaire was validated by a three-day estimated dietary record (3DR) among 210 school children. Statistical analysis by Spearman's correlation coefficients showed moderate to high correlations ($p <$ 0.001) between FFQ and 3DR (23).

Physical Examination

Prior to physical examination, a brief presentation and demonstration was given to teachers and students involved in all schools (Figure 1). Consent form was distributed and recollected a week before physical examination was conducted.

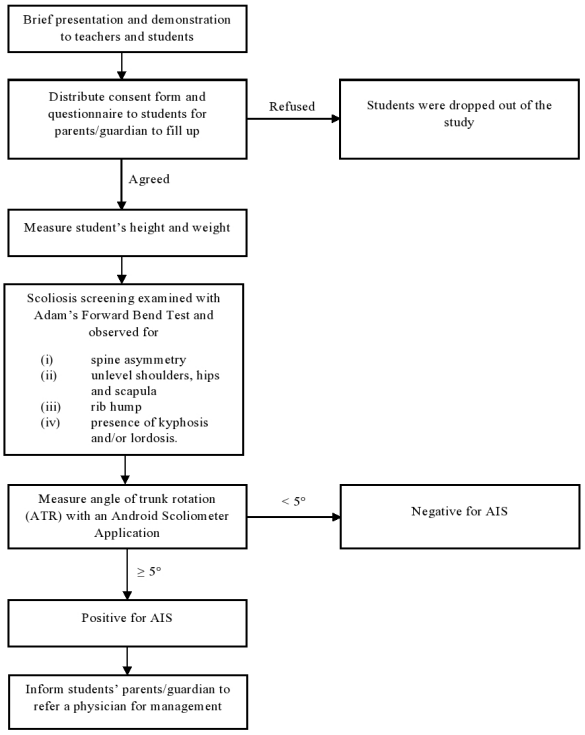

Figure. 1. Physical examination of primary school students between age 10 and 12 years old

On the physical examination day, students heigh and weight was measured using a stadiometer and weighing scale, respectively. Scoliosis screening using Adam's Forward Bend Test was performed. The students back were viewed from anteriorly, posteriorly and laterally for signs of (i) spine asymmetry, (ii) unlevel shoulders, hips and scapula, (iii) rib hump and (iv) present of kyphosis and/or lordosis. The angle of trunk rotation (ATR) was measured using an Android scoliometer application (Scoliometer, Version 4.2) created by Dr Kevin Lau (24). The accuracy of a scoliometer app has been validated by other researchers (25). ATR of 5 degrees and more at the thoracic and lumbar region was considered as positive for scoliosis. Parents/guardians to these students were advised to confirm the diagnosis with a whole-spine radiograph by a physician at the nearest hospital.

Statistical Analysis

Data obtained from the questionnaire and screening was analysed using SPSS version 21. Descriptive analysis was used to calculate the frequency, percentage, mean or standard deviation of students demographic data (age, ethnicity, gender, parents/ guardian monthly salary, weight, height and BMI). The association between variables was analysed using crosstab and Pearson chi-square.

RESULT

A total of 598 students from six primary schools were recruited in this study. However, only 374 students were included. Dropout rate was 37.5% either because parents/guardians refused to participate, questionnaire was incomplete, or the students were absent on examination day.

Demographic Data

Students recruited in this study were females aged between 10 and 12 years old with mean age of 10.83 ± 0.73 (Table I). Almost half of the students in this study were 11 years old followed by 10 years old and 12 years old which gave a percentage of 43.6%, 36.9% and 19.5% respectively. Half of the students were Malay (50.3%) followed by Indian (37.2%), Chinese (12.0%) and others (0.5%).

Based on the household income, the highest income frequency was between RM 1000 – RM 2500 (32.9%), followed by income more than RM 4000 (17.6%), income less than RM 1000 (17.4%), income between RM 2500 to RM 3000 (15.0%) and income between RM 3500 to RM 4000 (10.4%).

In terms of mean weight and height, students aged 10 years old were 32.15 kg ± 9.88 unit and 1.31 m ± 0.09 unit respectively. More than half of the students were underweight while slightly more than one third had normal BMI with 57.7% and 32.8% respectively. About 6.6% students were overweight and 2.7% of them were

Table I. Demographic Data

Variable	Frequency	Percentage (%)
Age (mean ± SD)	10.83	0.732
10 years old	138	36.9
11 years old	163	43.6
12 years old	73	19.5
Race		
Malay	188	50.3
Indian	139	37.2
Chinese	45	12.0
Others	2	0.5
Household income		
< RM 1000	65	18.6
RM 1000 – RM 2500	123	35.2
RM 2500 – RM 3500	56	16.0
RM 3500 – RM 4000	39	11.2
>RM 4000	66	18.9
Weight, kg (mean ± SD)		
10 years old	32.158	9.886
11 years old	38.020	10.973
12 years old	39.644	12.222
Height, m (mean ± SD)		
10 years old	1.312	0.093
11 years old	1.378	0.091
12 years old	1.461	0.070
BMI		
Underweight		
10 years old	79	57.7
11 years old	73	45.1
12 years old	42	58.3
Normal		
10 years old	45	32.8
11 years old	65	40.1
12 years old	24	33.3
Overweight		
10 years old	9	6.6
11 years old	21	13.0
12 years old	4	5.6
Obese		
10 years old	4	2.9
11 years old	3	1.9
12 years old	2	2.8

obese.

Mean weight and height for students aged 11 years old were 38.02 kg ± 10.97 and 1.37 m ± 0.09 respectively. About 45.1% of the students were underweight, 40.1% with normal BMI, 13.0% were overweight and 1.9% were obese.

Meanwhile for students aged 12 years old, mean weight was 39.64 kg ± 12.22 while mean height was 1.46 m ± 0.07. Students with underweight BMI were 58.3% and normal BMI were 33.3%. Less than 10% of 12-year-old students were overweight and obese, giving 5.6% and 2.8% respectively.

Prevalence Rate of AIS

Out of 374 students, 21 of them had angle of trunk rotation (ATR) of more than 5°. These students were considered positive for scoliosis making the prevalence rate 5.6% among school children in Sekolah Kebangsaan Sri Langat, Sekolah Kebangsaan Batu Laut, Sekolah Kebangsaan Tanjung Sepat, Sekolah Jenis Kebangsaan (C) Kah Wah, Sekolah Jenis Kebangsaan (T) Telok Datok and Sekolah Jenis Kebangsaan (T) Simpang Morib.

Association between Age of Menarche with Prevalence of AIS

The results from Tanner scale showed no association with the prevalence of AIS in female primary school children (Table II). Out of 374 participants, 49 students have reached their menarche age while the remaining 325 students have not. Out of these 325 students that have not reached menarche, 18 students were positive for AIS (85.7%) and started menstruation at the age of 11 years old, followed by 10 years old and 12 years old with 54.3%, 32.6% and 13.0% respectively. Meanwhile, out of 49 students that have started menstruation, three students were positive for AIS while the remaining 46 students were negative. They started menarche at the age of 10, 11 and 12 years old (33.3% each).

Results from this study showed that most students did not have any underarm hair growth. Three-quarter students who were negative for AIS did not have underarm hair (81.3%) and the remaining one-quarter showed growth of underarm hair (7.7%) followed by barely growth of underarm hair (2.8%) and completed growth of underarm hair (2.3%). Approximately 6.0% of the student's parents/guardians did not know if their child has underarm hair. Less than three-quarters of students with positive AIS showed no growth of underarm hair (76.2%) followed by started growth of underarm hair (12.9%). No students were listed under the barely started growth and completed growth of underarm hair.

The growth of pubic hair was graded according to Tanner scale. Approximately 83.5% students with negative AIS were graded stage I followed by 8.4% in stage II, 7.2% in stage III, 0.3% in stage IV and 0.6% in stage V. Meanwhile, three quarter of students positive with AIS was found in stage I followed by stage II and stage III with 70%, 20% and 10% respectively. No students were graded in stage IV and V.

Out of 353 students negative with AIS, 72.3% students

Table II. Association between Age of Menarche and Prevalence of AIS

Variable	Positive AIS (n=21)		Negative AIS (n=353)		X^2 statistic (df)	P - value
	Frequency	**Percentage within positive AIS (%)**	**Frequency**	**Percentage within negative AIS (%)**		
Had/having menstruation					0.027 (1)	0.746[a]
No	18	85.7	307	87.0		
Yes	3	14.3	46	13.0		
Age of period						
10 years old	1	33.3	16	32.6	0.828 (2)	0.735[a]
11 years old	1	33.3	25	54.3		
12 years old	1	33.3	7	13.0		
Growth of underarm hair					4.272 (4)	0.428[a]
No, growth of underarm hair has not yet started	16	81.0	286	81.3		
Barely started growth of underarm hair	0	0.0	10	2.8		
Definitely started growth of underarm hair	4	19.0	27	7.7		
Completed growth of underarm hair	0	0.0	8	2.3		
Don't know	1	4.8	21	6.0		
Pubic hair development according to Tanner stage					3.591(4)	0.261[a]
Stage I	14	70.0	278	78.8		
Stage II	4	20.0	28	7.9		
Stage III	2	10.0	24	6.8		
Stage IV	0	0.0	1	0.3		
Stage V	0	0.0	2	0.6		
Skin changes					4.100(4)	0.323[a]
No, skin changes has not yet started	12	57.1	253	72.3		
Barely started showing skin changes	0	0.0	8	2.3		
Skin changes are definitely underway	5	23.8	45	12.9		
Completed skin changes	0	0.0	8	2.3		
Don't know	4	19.0	36	10.3		

[a] Fisher Exact test

did not show any changes to their skin, followed by 12.9% students with changes underway, 2.3% students barely started showing skin changes and 2.3% students with completed skin changes. However, about 10% of the students' parents/guardian did not know if skin changes had occurred on their child. Meanwhile for students with AIS, more than half do not have changes on their skin (57.1%) followed by skin changes underway (23.8%) and 19.0% did not know if there are any skin changes.

Association between Dietary Intake with Prevalence of AIS

Table III shows the association between dairy intake with the prevalence of AIS. There is no association between the intake of milk with the prevalence of AIS (P = 0.165). Consumption of milk as beverage in AIS students showed slightly more than one third of students drank milk on a per month basis or less (35.8%) followed with 2-3 times per month (16.3%), 1-2 times per week (15.4%), 5-6 times per week (9.5%) and once per day (9.5%). The

Table III. Association between Dietary Intake with Prevalence of AIS

Variable	Positive AIS (n=21)		Negative AIS (n=353)		X^2 statistic (df)	P - value
	Frequency	**Percentage within positive AIS (%)**	**Frequency**	**Percentage within negative AIS (%)**		
How often did your child drink milk as a beverage (NOT in coffee, NOT in cereal)						
Once per month or less	6	35.8	119	28.6	10.357 (8)	0.165[a]
2 – 3 times per month	5	16.3	54	23.8		
1 – 2 times per week	2	15.4	51	9.5		
3 – 4 times per week	2	6.6	22	9.5		
5 – 6 times per week	1	4.8	12	3.6		
Once per day	2	9.5	51	15.4		
2 – 3 times per day	1	4.8	17	5.1		
4 – 5 times per day	2	9.5	2	0.6		
6 times or more per day	0	0.0	4	1.2		
How much do your child drink the milk?						
Less than 1 cup (8 oz)	12	57.1	194	58.6	0.883 (2)	0.643[b]
1 – 1 cup (8 – 12 oz)	6	28.6	109	32.9		
More than 1 cup (12 oz)	3	14.3	28	8.5		
How often do they drink yogurt as beverage?						
1 day per month or less	7	33.3	132	39.5	7.522 (5)	0.139[a]
2 – 3 days per month	3	14.3	82	24.6		
1 day per week	2	9.5	34	10.2		
2 – 3 days per week	2	9.5	23	6.9		
4 – 5 days per week	2	9.5	4	1.2		
Almost never or never	5	23.8	59	17.7		
How often do they eat cheese?						
1 day per month or less	7	35.0	175	54.9	8.462 (5)	0.131[a]
2 – 3 days per month	7	35.0	74	23.2		
1 day per week	2	10.0	46	14.4		
2 – 3 days per week	4	20.0	20	6.3		
4 – 5 days per week	0	0.0	1	0.3		
6 – 7 days per week	0	0.0	3	0.9		
How much usually they eat cheese?						
Less than 1 ounce or less than 1 slice	10	50.0	187	61.7	1.123 (2)	0.570[b]
to 1 ounces or 1 slice	7	35.0	78	25.7		
More than 1 ounce or more than 1 slice	3	15.0	38	12.5		

[a] Fischer Exact Test
[b] Pearson Chi Square

students who drank milk 3-4 times per week, 5-6 times per week, 2-3 times per day was 6.6%, 4.8% and 4.8% respectively. However, no students were listed under drinking milk more than 6 times per day. Approximately 28.6% students with AIS negative consumed milk once per month and 23.7% drank milk 2-3 times per month. This was followed by a total of 15.4% students drank milk once per day meanwhile 9.5% drank milk 1-2 times per week and 3-4 times per week, 5.1% drank 2-3 times per day, 3.6% drank 5-6 times per week, 1.2% drank 6 times or more per day and 0.6% drank 4-5 times per day.

More than half of the students with AIS consumed milk less than 1 cup (8 Oz) followed by 1-1 cup (8 – 12 Oz) and more than 1 cup (more than 12 Oz) with 57.1%, 28.6% and 14.3% respectively. The sequence is also the same in students with AIS negative with 58.6%, 32.9% and 5.8% respectively. The results showed no association between the amount of milk serving with the prevalence of AIS in female primary school children (P=0.643).

Similarly, the frequency of yogurt consumption has no association with the prevalence of AIS (P=0.139). The highest frequency on yogurt consumption by students with AIS was 1 day per month or less (33.3%) and 14.3% consumed for 2-3 days per month. About 9.5% drank

Table IV. Association between Physical Activity with Prevalence of AIS

Variable	Positive AIS (n=21)		Negative AIS (n=353)		X^2 statistic (df)	P – value[a]
	Frequency	**Percentage within positive AIS (%)**	**Frequency**	**Percentage within negative AIS (%)**		
Playing sport						
Yes	18	80.2	279	85.7	0.387 (1)	0.777[a]
No	3	19.8	69	14.3		
How many days per week spent playing sport?						
1 – 2 days per week	11	61.1	161	57.5		
3 – 4 days per week	2	11.1	50	17.9	1.522 (2)	0.622[a]
5 or more per week	2	11.1	15	5.4		
It varies	3	16.7	54	19.3		
How many hours per day sitting watching television?						
0 – 1 hour per day	7	38.9	94	33.5		
2 – 3 hours per day	5	27.8	134	47.7		
4 – 5 hours per day	5	27.8	33	11.7	5.492(4)	0.219[a]
6 – 7 hours per day	1	5.6	13	4.6		
8 hours per day	0	0.0	7	2.5		
How many hours per day seated using computer / laptop / handphone per day?						
0 – 1 hour per day	13	65.0	232	70.1		
2 – 3 hours per day	5	25.0	80	24.2	1.755(3)	0.504[a]
4 – 5 hours per day	2	10.0	14	4.2		
6 hours or more per day	0	0.0	5	1.5		
How many hours sleeping within 24 hours?						
0 – 6 hours	1	4.8	31	8.9		
7 hours	7	33.3	128	36.9	0.925 (3)	0.696[a]
8 – 9 hours	12	57.1	179	51.6		
10 hours or more	1	4.8	9	2.6		
Have been in back pain within 3 months back?						
Yes	1	4.8	18	5.2	0.008 (1)	1.00[a]
No	20	95.2	327	94.8		

[a] Fischer Exact Test

yogurt 1 day per week, 2-3 days per week and 4-5 days per week. Meanwhile, 23.8% students almost never or has never consumed yogurt. More than one third among the students with negative AIS drank yogurt 1 day per month or less followed by 2-3 days per month, 2-3 days per week and 4-5 days per week with 39.5%, 24.6%, 10.2%, 6.9% and 1.2% respectively. Approximately 17.7% of students negative with AIS almost never or have never drank yogurt.

The frequency of eating cheese also showed no association with the prevalence of AIS (P= 0.131). A total of 54.9% students without AIS and 35% with AIS ate cheese once per month or less. Meanwhile, 35.0%

students with AIS ate cheese 2 to 3 times per month as compared to 23.2% students that are negative with AIS. A total of 10.0% AIS students and 14.4% students without AIS ate cheese 1 time per week. This was followed with 20.0% students with AIS ate cheese 2 to 3 times per week as compared to 6.3% students negative with AIS.

The amount of cheese taken per serving for less than 1 ounce or less than 1 slice in students negative with AIS were 61.7% while students with AIS was 50.0%. Meanwhile, in students negative with AIS, 25.7% ate 1 ounces of cheese or 1 slice and in students with AIS were 35.0%. A total of 15.0% students with AIS ate cheese more than 1 ounce or more than 1 slice while in students negative with AIS were 12.55%. The p value showed no significant differences between group (P= 0.570).

Association between Physical Activities with Prevalence of AIS

Table IV shows 80.2% students with AIS played sports and the remaining 19.8% did not played sports. Meanwhile in AIS negative students, 85.7% played sports and 14.3% did not. However, statistical analysis showed there were no association between playing sports with the prevalence of AIS (P = 0.777).

In students negative with AIS, a total of 57.5% students played sports for 1 to 2 days per week, 19.3% students had variation in the frequency they played per week, 17.9% students played 3 to 4 days per week and 5.4% students played 5 or more days per week.

The results did not differ much from those with AIS, 61.1% of them played sports for 1 to 2 days per week followed by 16.7% had variation in the frequency they played per week. The results also showed no significant association between the frequency of playing sports per week with the prevalence of AIS (P = 0.622).

The results for duration spent watching television per day did not have any association with the prevalence of AIS (P = 0.219). Among the AIS negative students, slightly less than half watched television 2-3 hours per day (47.7%) followed by one-third of students watched television for 0-1 hour per day (33.7%). Approximately 11.7% students watched television for 4-5 hours per day followed by 4.6% that watched for 6-7 hours per day. A small number of students (2.5%) spend 8 hours per day watching television.

On top of that, the duration of students spends sitting while playing gadget such as computer, laptop and handphone also showed no association with the prevalence of AIS (P=0.504). Almost two-thirds of students with AIS sat for 0-1 hour per day (65.0%) to play gadgets. This followed by 2-3 hours per day (25.0%) and 4-5 hours per day (10.0%). There was no student listed playing gadget for 6 hours or more per day. Meanwhile, almost three-quarters of students negative with AIS played gadgets for 0-1 hour per day followed by 2-3 hours per day, 4-5 hours per day and 6 hours or more per day were 70.1%, 24.2%, 4.2% and 1.5% respectively.

In addition, sleeping duration per day also showed no significant association with the prevalence of AIS (P=0.696). Among students with positive AIS, more than half slept 8-10 hours per day (57.1%) and one third of them slept for 7 hours per day (33.5%). Approximately 4.8% students slept for 0 -6 hours and 10 hours or more.

Among students with negative AIS, slightly more than half of them slept for 8-10 hours (51.6%) while more than one third slept for 7 hours (36.9%). A total of 8.9% slept for 0-6 hours per day and lastly 2.6% slept for 10 hours or more. The results also showed most of the students negative and positive with AIS did not have back pain in the last three months with 95.2% and 94.8% respectively. Statistical analysis showed no association between back pain and AIS.

Association between Race and Prevalence of AIS

Table V shows the association between race and prevalence of AIS. Statistical analysis showed no association between race and the prevalence of AIS (P=0.611). From the total students, Malay race had the highest prevalence rate for AIS (2.9% of the total students) followed by Indian (1.9% of the total students) and Chinese (1.1% of the total students).

Table V. Association between Race and Prevalence of AIS

			Race				X^2 statistic (df)	P - value
			Malay	Chinese	Indian	Others		
Result of AIS	Negative (n= 353)	Frequency	177	41	132	2	1.148 (3)	0.611[a]
		% within race	94.1	91.1	95.0	100.0		
		% of total	47.3	11.0	35.3	0.5		
	Positive (n= 21)	Frequency	11	4	7	0		
		% within race	5.9	8.9	5.0	0.0		
		% of total	2.9	1.1	1.9	0.9		

[a] Fisher Exact Test

DISCUSSION

Prevalence of Adolescent Idiopathic Scoliosis Among Primary School Children

The prevalence rate of Adolescent Idiopathic Scoliosis (AIS) in this study was 5.6%. The rate was much higher as compared to the 2.0% prevalence rate obtained among primary school students from Terengganu (9). The discrepancy of prevalence rate is probably due to the (i) number of students that were recruited (ii) age and (iii) value of ATR. The study performed in Terengganu Primary schools recruited 832 female students as compared to our study which was 374 students. The researchers only recruited 12-year-old female students in their study. Findings from our study was consistent with previous study where female students at the age of 10 and 11 can develop AIS (26). It is possible that the rapid increase during an adolescent's growth could not keep up with the symmetry thickening of the vertebrae (15). The vertebrae become wedged causing the trunk to rotate laterally. Study from Terengganu Primary schools suggested scoliosis is present when the value of ATR is 7° and more. However, the value of ATR indicating the presence of scoliosis in our study was 5° and more which is the routinely used cut-off value (27).

Age of Menarche and AIS

Our study showed no association between age of menarche with the prevalence of AIS. Out of 21 students with AIS, 18 have not started menarche. These students were associated with lack of sexual maturation characteristics where their underarm and pubic hair have not started growing, indicating puberty have not begun.

Previous study reported that students with AIS started menstruation at a later age (28). The first sign of pubescence usually appears two years before menarche. At this point, an adolescent's growth rate increases by 0.5cm per month and can reach up to 6.0 to 7.0 cm per year (29). Bone rapidly grows for two years followed by a deceleration phase for three years where the growth rate reduces (28). The vertebrae become vulnerable towards deformity during the period of rapid growth. Study demonstrated that menarche begins at the deceleration phase of bone growth. If age of menarche is delayed, the skeletal growth period becomes longer and the adolescent is at risk of developing bone deformity (28).

Dietary Intake and AIS

In our study, the frequency of milk intake and the amount drank showed no association with the prevalence of AIS. Similarly, previous study showed no significant differences in the amount of calcium intake between AIS positive and negative groups (30). Our findings showed the dairy intake for both students with and without AIS did not adhere to The Malaysian Dietary Guideline (MDG) for Children and Adolescent (2014) (31). Adolescents are recommended to drink 2 to 3 servings of milk per day and consume 1 cup of yoghurt or 1 slice of cheese per serving per day. However, students from our study showed they drank milk less than half a cup per serving with a frequency of once per month. Majority of the students consumed yoghurt 1 cup per month or less. Nevertheless, in a study with 47.8% prevalence rate of AIS showed that dietary intake was not significantly associated with AIS (32).

Study performed in Kelantan showed that children living in urban area consumed dairy product more frequent than those in rural areas (33). This is because a household income influences a family's decision on the type of food to purchase (33). A low-income family usually do not afford to purchase high quality and animal sourced food. This leads to inadequate dietary intake in terms of quality and quantity. Our study was also conducted in a rural area where majority of the household income was between RM 1000 and RM2500 per month. It is possible that insufficient consumption of dairy product is related to their parents/guardians low purchasing power.

Physical Activity and AIS

Our study showed no association between physical activity and the prevalence of AIS. Majority of the students with and without AIS played sports 1 to 2 times per week. The recommended exercise program for adolescent is 60 minutes per day with moderate to vigorous activity daily (21). However, the type and duration of physical activity was not questioned in our study.

Physical activity can be divided into non-weight bearing and weight bearing exercises to promote bone density. Weight bearing exercise includes high and medium exercises such as walking, jogging, running, jumping, badminton and field events (30). During weight bearing exercise, tension is exerted to the muscles to stimulate new bone cells called osteoblasts and produce bone mineralization proteins to increase bone mass density (BMD) (14). Study have reported BMD in AIS children aged 13 years old and older was lower by 8.4% as compared to those without AIS (34). These children are at risk of developing osteoporosis or osteopenia later in life (34).

At the same time, mechanical tension applied during physical activity increases compressive force on the epiphyseal palate to promote lengthening of the vertebrae (15). In case there is unequal tension applied, the vertebrae will lengthen asymmetrically and form a wedge. The spine curves as it grows and muscles are forced to work asymmetrically which leads to back pain (15, 35). In our study, out of 21 students with AIS, one student was reported to have back pain. Since the degree of curve in our study was between 5° and 13°, the mild curve did not cause back pain. The pain intensity increases depending on the curve severity (35).

Our study suggest that majority of the students live a sedentary lifestyle as they spend most of their time studying, doing homework, going for tuition, watching television, or playing video games. Study have shown students routinely doing these activity for more than eight hours a day is considered living in a sedentary lifestyle. The advancement of gadget and social media influences children to spend most of their time on gadgets rather that playing sports. This will eventually influence their eating behaviour and body weight (36).

Race and Prevalence of AIS

The findings from this study showed no association between ethnicity and prevalence of AIS. Out of 21 students with AIS, 11 of them were Malay, 4 of them were Chinese and the remaining were Indian. From the results, Malay showed the highest prevalence towards AIS followed by Indian and Chinese. Nevertheless, this finding is not conclusive because the ratio between the three ethnicities was not equal.

A study from Singapore demonstrated that Chinese has the highest prevalence of AIS when compared with other ethnicity (26). Like our study, their findings are not conclusive as the number of students recruited were 31 532 Chinese, 5 096 Malay, 2 829 Indians and 1 017 others.

CONCLUSION

The prevalence rate of AIS in this study was 5.6%. However, no association was seen between age of menarche, dietary intake, physical activity, and ethnicity with the prevalence of AIS.

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