

# Prevalence of vitamin D deficiency rickets in adolescent school girls in Western region, Saudi Arabia

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## ABSTRACT

**Objectives:** To determine the prevalence of vitamin D deficiency rickets among female adolescents and assess its relation to calcium intake and sun exposure.

**Methods:** Four hundred and thirty-three school girls between 12-15 years old were selected randomly from different schools in Jeddah, between October 2003 - February 2004. We identified symptoms of rickets and determined the dietary habits and sun exposure habits, and laboratory investigations were also carried out,

**Results:** It was found that, out of 433 cases, 350 (81%) had low vitamin D levels. Approximately 40% had very low levels of vitamin D and 61% were asymptomatic. Most of the symptoms were non specific. There was a positive correlation between low calcium in the diet and less sun exposure to low levels of vitamin D. Approximately 96% had normal serum phosphate, 89% had normal serum calcium, and 40% had normal serum alkaline phosphatase levels.

**Conclusion:** Vitamin D deficiency is common among adolescent females in Jeddah, Saudi Arabia. Cases are missed due to lack of symptoms in most cases and normal bone chemistry. Serum vitamin D level should be carried out in suspected cases. Health and nutritional education should be encouraged in schools. Focusing on the importance of adequate milk intake and sun exposure should be given a priority in any health education program.

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Vitamin D metabolites are important for the normal development of bone and the metabolism of its constituent ions. Deficiency or abnormal metabolism of vitamin D is often responsible for rickets. There is little vitamin D in the ordinary diet and the major source of vitamin D is the vitamin D<sub>3</sub> synthesized in the skin when it is exposed to ultraviolet light.<sup>1</sup> Growing age groups (children and adolescents) are in a critical period for skeletal mass accretion,<sup>2-3</sup> where adequate sun exposure is needed. Female adolescents may be more vulnerable especially Asians, as it was found in many countries that Asian females have low levels of vitamin D.<sup>4-11</sup>

In Saudi Arabia, many studies were carried out to study Osteomalacia and Rickets in different age groups and both sexes, but recently, only few studies were conducted on healthy adult females,<sup>12-14</sup> and few on symptomatic adolescents with rickets.<sup>15-18</sup> Some data are available on vitamin D status in adolescents carried out in 1992,<sup>7,8</sup> but since then, no further studies have been carried out to assess the prevalence of vitamin D deficiency in adolescent females, although there is an impression from clinical practice that it is not uncommon. The aim of our study is to screen adolescent school girls aged 12-15 years, in which a physiological growth spurt occurs and vitamin D deficiency can occur quickly and asymptotically. This study looks into the prevalence of vitamin D deficiency rickets among this group in Jeddah City of Saudi Arabia, studies the symptoms and blood bone chemistry, and identifies causative factors by reviewing the dietary habits and sun exposure.

**Methods.** This research was funded by King Abdulaziz University, Jeddah. The collection of the data and blood samples took place between October 2003 – February 2004. Six hundred female students aged 12-15 years were randomly selected from 6 schools chosen from different areas of Jeddah and the questionnaires were distributed to them, which reviewed the dietary habits, dairy products consumption, exposure to sun, and presence or absence of any symptoms. Four hundred and thirty-three students were included in the study, who had no history of renal, hepatic diseases, or malabsorption, no family history of

rickets, and were not on anti-convulsant therapy or vitamin supplementations. Laboratory investigations included blood bone chemistry (calcium, phosphate, and alkaline phosphatase), parathyroid hormone assay, and serum concentration of 25-hydroxyvitamin D (25-OHD), which was measured using enzyme-linked immunosorbent assay (ELISA) technique (K2110, Immunodiagnostic [Dutch Company], Holland). Symptomatic vitamin D deficiency rickets was defined by the presence of muscle, bone or back pain, muscle spasms, or twitches in addition to serum (25-OHD) concentrations of <25 nmol/L (n=25-125 nmol/L). Asymptomatic vitamin D deficiency rickets was defined by the presence of serum 25-OHD concentrations of <25 nmol/L, with no symptoms. Severe vitamin D deficiency was defined by the presence of serum 25-OHD concentrations of <12.5 nmol/L.

Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 10. Chi square test was used to analyze group differences for categorical variables. For continuous variables, t-test was used. *P* value of <0.05 was considered significant.

**Results.** Out of 433 girls, 350 (81%) had low vitamin D levels, ranging from 2.2-24.0 nmol/L. Approximately 194 girls were Saudi by birth (56%). Two hundred thirteen girls were asymptomatic (61%). Back pain was the most common complaint as shown in **Table 1**. A severe vitamin D deficiency was noticed in 173 (40%) girls of the total population studied. The intake habits of dairy products in the low vitamin D girls, showed that only 125 (36%) had daily consumption versus 170 (48%) who rarely had any, and that was statistically significant with *p* value of 0.013. Out of 150, only 31 (21%) took near the daily requirement of milk such as >3 cups or equivalent of milk products, but that was not statistically significant with *p* value of 0.13 due to the girls who answered this part of the questionnaire were few. The sun exposure habits in the low vitamin D, girls showed that 67 (19%) were never exposed to sun, 205 (67%) were exposed in less than 15 minutes, and 235 (75%) had indirect exposure. That was statistically significant with *p* values of 0.013, 0.041, and 0.007.

Cases with a severe vitamin D deficiency (very low vitamin D levels) were significantly more prevalent with lower income and with rare sun exposure [*p*=0.015 (**Table 2**)] and [*p*=0.01 (**Table 3**)]. **Table 4** shows number of rachitic girls who had low calcium and phosphate and high alkaline phosphatase and parathormone levels. It was noticed that the severity of vitamin D deficiency had no relation to the serum levels of calcium, phosphate, and alkaline phosphatase, but was inversely related to the parathormone levels

**Table 1** - Prevalence of symptoms in 350 girls with rickets.

Symptoms	n (%)
Back pain	92 (26)
Bone pain	50 (14)
Twitches	15 (4)
Muscle pain	13 (4)
Cramps	11 (3)

**Table 2** - Relation of very low vitamin D level (<12.5 nmol/L) to the family income.

Income (Saudi Riyals)	Vitamin D level above 12.5 nmol/L n (%)	Vitamin D level below 12.5 nmol/L n (%)	Total n (%)
3000	40 (37)	67 (63)	107 (37)
3000 – 8000	42 (53)	38 (47)	80 (28)
>8000	57 (56)	44 (44)	101 (35)
<b>Total</b>	<b>139 (48)</b>	<b>149 (52)</b>	<b>288 (100)</b>

*P* = 0.015

**Table 3** - Relation of very low vitamin D level (<12.5 nmol/L) to sun exposure.

Sun exposure	Vitamin D level above 12.5 nmol/L n (%)	Vitamin D level below 12.5 nmol/L n (%)	Total n (%)
Daily	129 (55)	104 (45)	233 (78)
Never	24 (37)	43 (63)	67 (22)
<b>Total</b>	<b>153 (51)</b>	<b>147 (49)</b>	<b>300 (100)</b>

*P* = 0.01

**Table 4** - Abnormal biochemical values of the 350 rachitic girls.

Normal value	n (%)
High alkaline phosphatase (0 - 250 u/l)	211 (60)
High parathormone (1.6 – 6.5 pmol/l)	149 (43)
Low calcium (2.1 – 2.6 mmol/l)	39 (11)
Low phosphate (0.81 – 1.58 mmol/l)	14 (4)

**Table 5** - Intake of dairy products in symptomatic and asymptomatic girls with rickets.

Intake	Symptomatic n (%)	Asymptomatic n (%)	Total n (%)
Daily	45 (36)	80 (64)	125 (36)
Twice/week	14 (26)	41 (74)	55 (16)
Rarely	78 (45)	92 (55)	170 (48)
<b>Total</b>	<b>137 (39)</b>	<b>213 (61)</b>	<b>350 (100)</b>

*P* = 0.024

with a significant  $p$  value of 0.002. Symptoms of rickets had no relation to the severity of vitamin D deficiency, to serum calcium levels nor to the sun exposure habits ( $p=0.3, 0.25, 0.3$ ), however, they were related to daily intake of dairy products with  $p=0.024$ , that were statistically significant. **Table 5** shows intake habits of dairy products in the symptomatic and asymptomatic girls with rickets.

**Discussion.** In the past, vitamin D deficiency rickets was seen in the poor areas of Europe and North America, before it was eradicated by fortification of milk and infant foods with vitamin D.<sup>19</sup> In Europe, it is mainly seen in the Asian community,<sup>4,6,9,20</sup> but recently, few studies show its presence in Europe and North America in the winter, specially in adolescents and young adults.<sup>21-25</sup> In Saudi Arabia, inadequate vitamin D levels were detected in a population based study and is shown that vitamin D deficient osteomalacia/rickets is not uncommon and it is higher in female adolescents and adults.<sup>7,8</sup>

Our study shows a higher prevalence of vitamin D deficiency than in other studies. The United Kingdom reported 6% and 44%,<sup>4,26</sup> Lebanon 53.5% and 74%;<sup>5</sup> Saudi Arabia 38.6%;<sup>8</sup> China 54.6%;<sup>10</sup> Spain 31%,<sup>21</sup> Finland 67.7%,<sup>23</sup> and France 34%.<sup>27</sup> The mean level of vitamin D was also lower than in other studies.<sup>5,7,21,23</sup> Our study also shows that the daily intake of dairy products was less in the girls with low vitamin D levels, and that 80% were taking below the daily allowance recommended by National Institute of Health.<sup>28,29</sup> It was also noted that girls who had symptoms did not consume dairy products daily, it means that the symptoms are directly and significantly related to the daily calcium intake. The reasons probably for less intake were ignorance or lack of education, the increased consumption of soft drinks instead of milk, and the fear from gaining weight. There was a direct relation between less sun exposure and low serum levels of vitamin D in our study. The issue of the duration of the sunlight exposure needed to maintain adequate stores of vitamin D has been controversial,<sup>30</sup> but recently, it was recommended to be 15 minutes of sunlight daily.<sup>31</sup> In Saudi Arabia, the exposure of people generally to the sun is limited, despite of abundant sunlight due to high daytime temperature.<sup>8,32-34</sup> Females tend to have less sun exposure due to sociocultural reasons, lack of awareness of the importance of sun exposure for bone health, and for cosmetic reasons thinking that it is harmful. It was noted that girls who had a severe vitamin D deficiency were rarely exposed to the sun and came from lower income families and that may be related to smaller crowded houses where sunlight does not reach. The presence of normal calcium and normal phosphate levels in most of the cases is interesting, and at the same

time, it is alarming as many cases of rickets could be missed if 25-OHD was not measured, especially that alkaline phosphatase levels were also normal in many cases. The presence of normal calcium levels in vitamin D deficient patients were also observed by Sedrani<sup>32</sup> in Saudi Arabia. The presence of compensatory high parathormone levels could contribute to normal serum calcium levels, which were observed in our study. An adolescent period is important in female life. Good nutrition to maintain calcium and vitamin D stores, and enough sun exposure is important for bone formation and prevention of osteomalacia/rickets. Adolescent rickets if not diagnosed, can progress to osteomalacia in adulthood and during pregnancy with probably serious consequences to both mother and the baby. There is also high risk of postmenopausal osteoporosis in these girls.<sup>35</sup>

In conclusion, vitamin D deficiency has a high prevalence in adolescent females in Jeddah area and probably in Saudi Arabia in general. Most of the cases are asymptomatic and if present, symptoms are non specific. This high prevalence of vitamin D deficiency is attributed to both lack of dietary dairy intake and to lack of sun exposure. Many cases of adolescent rickets are undiagnosed and we urge physicians to have a higher degree of clinical suspicion for hypovitaminosis D and to screen all the patients with non specific musculoskeletal pain by measuring 25-OHD. We also recommend improved dietary supplies of highly bioavailable calcium (such as milk) and vitamin D from food fortification, the improvement of sun exposure facilities in schools and the integration of the topic of vitamin D deficiency, and osteomalacia/rickets into the school syllabus in order to improve the health education of the students and the population as a whole. Furthermore, screening studies are needed in different regions of Saudi Arabia to assess the magnitude of this preventable problem.

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