

Calcium and Vitamin D Related Knowledge in 16-18 Years Old Adolescents: Does Living in Urban or Rural Areas Matter?

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Abstract

Background: Vitamin D deficiency is very common in Bangladesh. However, there is scanty of literature available about the knowledge of calcium and vitamin D in 16-18 years old adolescents. The present study has been conducted to determine whether a lack of knowledge exists in this age group about these nutrients and to find out the correlation between students' living in urban or rural areas.

Methods: We conducted a cross sectional survey in 2992 students living in urban (62.6%) and rural (37.4%) areas aged between 16-18 years. We followed a 2 step sampling technique. 6 colleges from both urban and rural areas were selected by convenience of the interviewers and then required sample size was calculated from the number of students of each college. The students filled up a questionnaire after a detailed briefing about the study by the interviewer.

Result: We found that many of the students, both from urban and rural settings have lack of knowledge and awareness of calcium and vitamin D. Our data suggest that though the rural students are less familiar with vitamin D ($p < 0.001$) and osteoporosis ($p = 0.0056$) than urban students, they exercise a healthy diet in terms of milk consumption ($p < 0.0001$) and engage themselves more in outdoor activities, spend more time in sunlight ($p < 0.0001$) than the urban students. Thus the rural students may require less supplemental support of calcium and/or vitamin D than the urban students ($p < 0.0001$).

Conclusion: Urban students are more familiar with the nutrients than the rural students but rural students' lifestyle, diet and food habit may allow them to get a healthier nutritional support and thus to have a better nutritional health than urban students.

Keywords: Adolescent; Healthy diet; Hypovitaminosis D; Nutrients; Nutrition knowledge; Osteoporosis

Background

In general, bone and bone related disorders, especially osteoporosis, fracture, are thought to be a concern of older age. It is usually a very common idea that the more you get aged, the more you lose your bone mass. Thus bones become fragile and increase the risk of bone related negative health outcomes. Interestingly, "bone health" is determined by the first 18 years of a man (or woman) as 90% of peak bone mass is attained by this age [1]. However, attainment of peak bone mass is related to a number of factors, i.e., the genotype [2], physical activity [3], diet [4] and maintaining an adequate vitamin D status [5]. Vitamin D is very important in maintaining bone health and the prevalence of vitamin D deficiency is thought to be related to numerous issues [6-9] including low intake of calcium and vitamin D [10,11].

During childhood and adolescence, vitamin D is important for calcium absorption and bone growth and accretion [12]. It is also plausible that calcium intake during adolescence and young adulthood affects skeletal growth and bone mineralization [13]. Thus, calcium and vitamin D both are essential nutrients for developing peak bone mass and bone health, and are associated with nutritional habit [14,15]. Results from different researches indicate that vitamin D deficiency is prevailing among adolescents and young adults [16,17]. However, it is to be acknowledged that not only calcium and vitamin D but also other nutrients are involved in bone health, i.e. phosphorous, potassium, magnesium, copper, zinc, vitamin C, vitamin K, B vitamins, phytoestrogens, nondigestible oligosaccharides (especially inulin-type fructans) etc. [18,19].

There is a widespread occurrence of vitamin D deficiency in South and Southeast Asian countries irrespective of gender and age [20,21] including Bangladesh [22-25]. Moreover, dietary calcium insufficiency in Bangladeshi population is also reported in literature [26]. It is assumed that there is lack of awareness among the people in Bangladesh about these nutrients [21]. But little work has been conducted to understand the prevailing lack of knowledge regarding these nutrients in the country. As lack of nutrition knowledge influences adolescent's food intake and behavior [27] and in most developing countries, the children in rural areas have a poorer nutritional status than the children in urban areas [28] we surmise that living in rural or urban areas play a considerable role in nutritional knowledge. Thus the present study has been conducted in Bangladeshi young people aged between 16-18 years to explore their knowledge about importance of these two

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nutrients, their intake pattern both in urban and rural settings. We also determined whether there is any difference in familiarity, knowledge and awareness of them with respect to living in urban or rural regions.

Methods

Study participants and study design

All the participants in the study are students who are studying at 11 and 12 years of schooling (Higher Secondary School Certificate level in Bangladesh). The students are within the age range of 16-18 years. We enrolled a total of 2 992 students, 1 872 (62.6%) from urban areas and 1 120 (37.4%) from rural areas. The sampling followed a 2 step protocol. First we selected 6 colleges from Dhaka and Chittagong urban areas and 6 colleges from Jessor, Naogaon, Feni, Gazipur, Faridpur and Rangpur rural areas. We preferred rural and urban colleges from different settings (not within the same region) purposefully. As per recent United Nations (UN) data, approximately 25% of Bangladesh's present population currently lives in urban areas. Of this urban population, more than half lives in the four largest cities: Dhaka, Chittagong, Khulna and Rajshahi [29]. Urbanization in Bangladesh has a different meaning and dimension in comparison to many other countries. In this country people living in the "rural areas" of Dhaka district have access to many modern facilities more than the people living in "urban areas" of other cities, even in other city headquarters. As Dhaka and Chittagong are the most developed cities of the country we pulled data from these two cities to represent "urban" community. And as we said earlier "rural" student's data were collected from the rural areas of Jessor, Naogaon, Feni, Gazipur, Faridpur and Rangpur. However, these districts were selected by the interviewers' convenience. Using Raosoft® online sample size calculator [30] we determined representative number of students from each college and finally students from the selected colleges were enrolled randomly. For example, there are 2,800 students studying in Urban college 1. So, with 5% margin of error, 95% confidence interval and assuming the response distribution as 50%, a sample size of 338 can be considered as representative sample for the particular college 1. This is how for each institution required sample size was determined and then total study population for both urban and rural settings were obtained (Figure 1).

All the institutions (colleges) and the students whom we requested, participated in the survey, no one refused to be a part of the study when we called for participation. In Bangladesh, students having a good result often get themselves admitted in urban colleges. These types of students were excluded from the study as they do not stand for the rural community.

Enrolment of the study participants in the survey

A representative sample was calculated using online sample size calculator by Raosoft Inc. from the number of students studying in the college with 5% margin of error, 95% confidence interval and assuming the response distribution as 50% (Figure 1).

Among the students 48.4% were male and 51.6% were female. An interviewer at each college briefed the students about the purpose of the study at their classes with prior permission from the authority of the college. After the briefing they were provided with a questionnaire. They were asked to fill up the questionnaire with the answer they think appropriate for them. The students were instructed not to answer multiple options for any question. No students were forced, by any means, to participate in the study. It was made clear that participating in the study will not benefit them to get marks in the exams and no financial benefit will be offered. The filled up questionnaires were collected by the interviewer at the end of the session.

Questionnaire design

We used a modified questionnaire previously used in another study [21]. We excluded some questions from the previous one and included some new. Briefly, the questionnaire was composed of simple questions, like familiarity with vitamins and minerals, importance of calcium and vitamin D, sources of calcium and vitamin D, familiarity with the term osteoporosis, frequency of milk consumption, daily sunlight exposure time and the source from where they came to know about the importance of the said nutrients. The questionnaire was written in both Bangla and English (English language question followed by its local language translation) for better understanding of the participants. Additionally, the interviewer was present at the class throughout the session and answered any relevant questions from the students while they were incapable to understand. The modified questionnaire was pilot tested before the survey being conducted.

Ethical considerations

The study was approved by the Institutional Ethics Committee, Stamford University Bangladesh (Ref: SUB/SHUM/13.08). Written permission was taken from each college authority and all the participants gave oral consent to take part in the study.

Statistical analyses

Statistical analyses were performed using MedCalc for Windows, version 12.7.0 (MedCalc Software, Ostend, Belgium). Results are reported as odd ratio with 95% confidence interval and $p < 0.05$ was considered statistically significant. Chi-squared test was used to assess

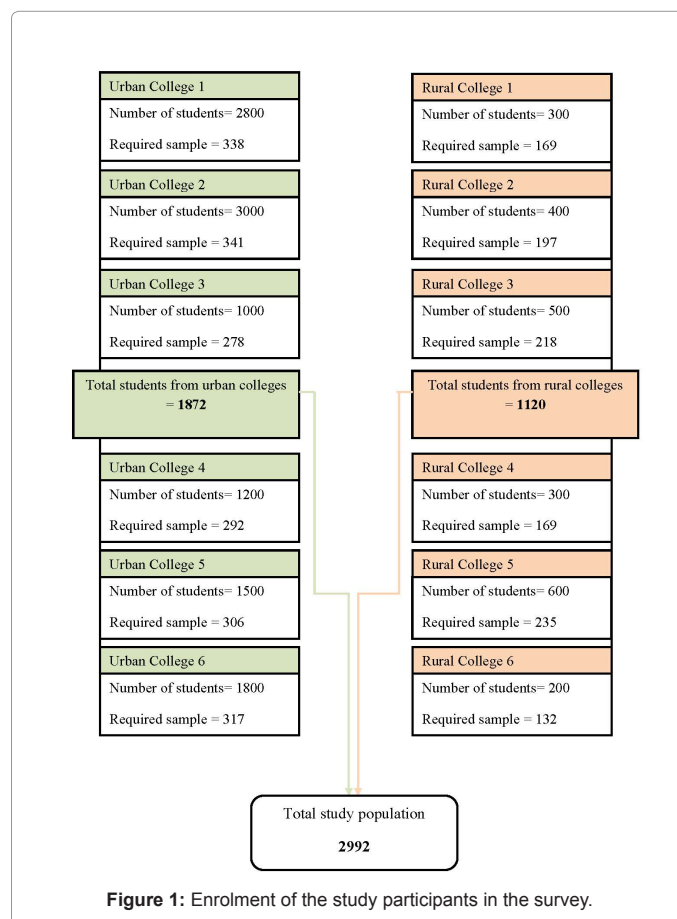


Figure 1: Enrolment of the study participants in the survey.

whether milk consumption pattern and daily sunlight exposure time differs for students residing in urban and rural settings.

Result

Calcium and vitamin D related basic knowledge

All the students participated in the study are aware of the fact that different vitamins and minerals are essential for a healthy life. However, some of the students think that calcium and vitamin D are not important nutritional components. There is no significant difference between urban and rural students' perception about the essentiality of calcium as a vital nutrient. But we observed significant lack of knowledge regarding necessity of vitamin D among rural students in comparison to urban students ($p=0.001$). Again, in response to the question "Sunlight may produce vitamin D: do you agree?" there was a significant difference in response among the urban and rural students ($p<0.05$). "Osteoporosis" is a familiar term to 61.2% and 56.1% of urban and rural students respectively and rural students are significantly less conversant with the term than the urban students ($p=0.0056$). However, we have found no statistically significant difference in their knowledge of source of calcium and vitamin D. 40.5% and 41.5% students from urban and rural colleges respectively were able to mention one name of calcium containing food and 39.5% and 38.0% students respectively from urban and rural colleges correctly pointed out one source of vitamin D. We asked the students "Have you ever been prescribed a calcium and/or vitamin D by your physician". We found that the rural students were prescribed significantly less calcium and/or vitamin D than the students coming from urban areas ($p<0.0001$). The results are summarized in Table 1.

Frequency of milk consumption and daily sunlight exposure

We asked the students "How frequently you have milk?". It was a multiple choice question and they were instructed to answer only one option. According to our analysis there is a strong association between a students' residence status and milk consumption frequency ($\chi^2=187.553$, $df=3$, $p<0.0001$). But from this finding we cannot clinch how much additional milk (in quantitative term) the students in rural

area consume in comparison to urban students. However, this data suggests that more students of urban area do not like milk compared to rural students. The students were also asked to provide us with information about their daily sunlight exposure (time spend at outdoor activities from the morning to evening). Also in this case we found that residence status is strongly associated with sunlight exposure ($\chi^2=1176.601$, $df=2$, $p<0.0001$) and hence from Table 2 we can accept that more students in rural areas stay at outdoor than urban students. The findings are tabulated in Table 2.

Source of knowledge of the micronutrients

Most of the students in our current study were learned of calcium and vitamin D from their teachers; 39.6% and 44.4% respectively for urban and rural students ($p=0.01$; significantly more students from the rural areas came to know about these nutrients from their teachers than the urban students). Textbooks were the second most common source; 29.4% and 35.8% for urban and rural students respectively ($p=0.0003$; significantly more students from the rural areas came to know about these nutrients from the textbooks than the urban students). It implies that most of the students first got familiar with the nutritional components from academic resources. This is probably due to the fact that in Bangladesh the students read chapters in their general science book issued by the National Curriculum and Textbook Board (NCTB) on the nutrients, i.e. vitamins and minerals at their primary education level (in between age 6-10 years) [21]. However, more students from urban colleges got familiar with the nutrients with the help of internet ($p<0.0001$). Table 3 summarizes the students' response in this regard.

Discussion

Nutritional food components, minerals and vitamins are essential for better living and health. Several researches found no strong associations between nutritional knowledge and food intake [31,32] which put a notion that "being knowledgeable about diet and health is of little relevance to choice of food" [27,31]. But the opinion is not beyond criticism as studies suggest that nutrition knowledge has the potential to improve dietary quality [27,33]. Lack of nutrition

Topic	Urban/ rural	Yes (%)	No (%)	OR (CI)	P value
Do you think vitamin and minerals are essential for health?	Urban	1872 (100)	0 (0)	-	0.8
	Rural	1120 (100)	0 (0)	-	
Do you think calcium is an important micronutrient?	Urban	1704 (91.0)	168 (9.0)	1	0.49
	Rural	1011 (90.3)	109 (9.7)	0.91 (0.71-1.18)	
Do you think vitamin D is essential for human health?	Urban	1677 (89.6)	195 (10.4)	1	0.001
	Rural	958 (85.5)	162 (14.5)	0.69 (0.55-0.86)	
Sunlight may produce vitamin D: do you agree?	Urban	1457 (77.8)	415 (22.2)	1	0.036
	Rural	834 (74.5)	286 (25.5)	0.83 (0.7-0.99)	
Are you familiar with the term "Osteoporosis"?	Urban	1146 (61.2)	726 (38.8)	1	0.0056
	Rural	628 (56.1)	492 (43.9)	0.81 (0.7-0.94)	
Name of at least one calcium containing food name‡	Urban	758 (40.5)	1114 (59.5)	1	0.5805
	Rural	465 (41.5)	655 (58.5)	1.04 (0.9-1.21)	
Name of at least one vitamin D containing food name‡	Urban	740 (39.5)	1132 (60.5)	1	0.39
	Rural	425 (38.0)	695 (62.0)	0.94 (0.08-1.09)	
Have you ever been prescribed a calcium and/or vitamin D by your physician? ¶	Urban	925 (49.4)	947 (50.6)	1	<0.0001
	Rural	313 (28.0)	807 (72.0)	0.4 (0.34-0.47)	

‡ The interviewers instructed the students not to mention milk or sunlight as a source as they are already mentioned in the questionnaire. In these cases we have not considered whether the food is available in Bangladesh or not

¶ Students were provided with some commercially available brand names of calcium and/or vitamin D supplements. The names were given for their better understanding. The authors have no financial or personal or otherwise any sort of relationship with the manufacturers of the brands. The brand names are not mentioned in the manuscript

Abbreviation: OR: Odd Ratio, CI: Confidence Interval

Table 1: Familiarity with the basics of calcium and vitamin D.

Frequency of milk consumption†					
Residence status		Daily	Weekly	Monthly	I don't like milk
	Urban (%)	156 (8.3%)	495 (26.4%)	269 (14.4%)	952 (50.9%)
	Rural (%)	273 (24.4%)	195 (17.4%)	223 (19.9%)	429 (38.3%)
Daily sunlight exposure‡					
Residence status		Less than 1 hour	More than 1 hour	Not specific	
	Urban (%)	1512 (80.8%)	129 (6.9%)	231 (12.3%)	
	Rural (%)	258 (23.0%)	698 (62.3%)	164 (14.6%)	

†Includes milk coming from any source as a drink but does not include chocolate milk, milk candy etc. ‡ Sunlight exposure means daily time spent outdoor from morning to evening

Table 2: Trend of milk consumption and sunlight exposure among the students.

Source	Urban (%)	Rural (%)	OR (CI)	P value
Parents, family members, relatives	165 (8.8)	92 (8.2)	0.93 (0.71-1.21)	0.57
Teachers	741 (39.6)	497 (44.4)	1.22 (1.05-1.42)	0.01
Physician	50 (2.7)	22 (2.0)	0.73 (0.44-1.22)	0.23
Textbooks	551 (29.4)	401 (35.8)	1.34 (1.14-1.57)	0.0003
Internet	256 (13.7)	51 (4.6)	0.30 (0.22-0.41)	<0.0001
Others	109 (5.8)	57 (5.1)	0.87 (0.62-1.21)	0.4

Abbreviation: OR: Odd Ratio, CI: Confidence Interval

Table 3: Source of information about the micronutrients.

knowledge influences adolescent's food intake and behavior [27]. In our current study we have found that a considerable number of college going students of Bangladesh aged between 16-18 years have lack of knowledge of two essential nutrients; calcium and vitamin D.

Universities and colleges represent the final opportunity for nutrition education of a large number of students [34]. It was previously found that the undergraduate pharmacy students of Bangladesh lack adequate knowledge about essential nutrients, minerals, vitamins etc. though they have a long academic record of studying in biological science [21]. Our findings in this current study is in agreement with the findings of previous one [21] that most of the students came to know about the importance of the nutritional components from academic sources (either from their teachers or from textbooks). As a result, it is not possible to criticize the education system itself for the knowledge gap. But we do believe that family should be more active and more informative regarding nutrition education as only 8.8% and 8.2% of our study participants from urban and rural colleges respectively responded that they first informed of the essentiality of calcium and/or vitamin D from their parents, family members or relatives.

In our current study we found that 13.7% urban students got familiar with calcium and vitamin D with the help of internet. In this regard we found a very significant difference between urban and rural students' response. In Bangladesh the use of information and communication technology (ICT) facilities are much more available in urban areas compared to rural areas [35]. Thus internet may be more accessible to urban students and they may be facilitated to use it for nutritional education purpose.

According to our survey results most of the students do not like milk (50.9% for urban students and 38.3% for rural students). Poor eating habit is common in adolescents. At adolescent age boys' and girls' frequency of moving away from home increases and they acquire more autonomy [34,36-40]. This behavioral change led to poor eating habit and may limit dietary consumption of fibers, calcium, vitamin C and

folate. However, there are some differences in dietary intake between urban and rural populations. Generally rural adults have higher intake of vegetables, dairy fats and oils [41]. This aspect may be the plausible reason that is why we found that the rural students have more milk/day than urban students. Our findings in respect to frequency of milk consumption by the students do not comply with McNaughton and her co-workers findings [42]. They conducted a survey among urban and rural children aged 5-12 years in Australia and found no significant difference between children living in urban and rural areas for intake of different milk products. This noncompliance may be due to the differences in demography and age of the participants.

We found that rural students spend more time at outdoor than urban students and thus may be exposed to more sunlight which is one of the most important sources of vitamin D. The skin has the ability to supply 80-100% of vitamin D requirements of the body [43] while lack of access to sunlight exposure may result in vitamin D deficiency. Individuals exposed to very limited amounts of sunlight become dependent on an oral intake of vitamin D [43]. As the students in rural colleges spend more time in sunlight and have more milk than urban students they may not need a calcium and/or vitamin D supplement being prescribed by their physicians. Thus in our current study we found that students coming from rural colleges have been prescribed calcium and/or vitamin D supplement less than the urban students. So, these finding also advocate that the adolescents at 16-18 years age should have a healthy diet, food rich in calcium and vitamin D and to expend sufficient time at outdoor.

However, in this current study we have considered all the students from rural colleges as a cluster that represents "rural students" and so for "urban students". We hypothesized that living in urban or rural area plays a role regarding knowledge on calcium and vitamin D. Thus multilevel analyses (students within schools) were not performed for this study.

We believe that increasing knowledge of the nutrients can facilitate improving nutritional health of the people residing in the country. Family should be the first place from where the children will learn about taking a healthy diet. So, the parents should be cooperative and play an active role, be more communicative and take necessary care to habituate their children to have a healthy diet. Media, both print and electronic, can play a key role for improving awareness in parents and children. Different government institutions like Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Institute of Public Health Nutrition (IPHN), Bangladesh, along with many non government organizations (NGOs) and international health organizations (like World Health Organization (WHO), The United Nations Children's Fund (UNICEF) etc.) can play significant role to increase nutritional awareness among people of different age groups in the country.

Limitations of the study

There are several limitations in our study. The colleges were selected by convenience of the interviewers, not randomly. As the students filled up the questionnaire by their own, we must rely on their honesty to respond question answers. The study does not shade any light with the potential relationship between knowledge of nutrients and differences in gender or social-financial status of the participants. Furthermore, we believe knowledge and awareness may be correlated to anthropometric measurements and bone health, i.e. bone mineral density (BMD) of the participants, which we could not perform due to our limitations. We also believe measurement of serum 25-hydroxyvitamin D and a correlation

with the knowledge would have made the study more clinical rather than general knowledge based. Moreover, though parent's education and family income are major determinants in nutritional habits, the study does not provide any information in this regard.

Conclusion

As the current study is not a national survey, the present findings do not allow us to conclude whether living in urban or rural area matter in nutritional knowledge at country level. But to our best knowledge, this is the first ever population based study on 16-18 years adolescents to evaluate their knowledge on calcium and vitamin D. Hence this can be considered as a baseline for future research in this particular area. We studied quite a large sample size and found rural students to have better dietary intake and sunlight exposure than the urban students though their nutritional knowledge is comparatively poor. Thus knowing more about vitamins, minerals and nutrients may not be related to a good nutritional intake in adolescents. Nevertheless we believe that necessary actions should be taken to improve the nutritional knowledge of the college students in Bangladesh to ensure a healthy future generation.

Competing interests

All the authors declare that they have no Competing interests, neither financial nor personal.

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