fortune Journals

Research Article

FORTUNE JOURNAL OF HEALTH SCIENCES

ISSN: 2644-2906

Vitamin D-3 Status of Critically Ill Patients Admitted at ICU with Multidisciplinary Diseases in a Tertiary Care Hospital

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Abstract

Introduction: Vitamin D is necessary to maintain serum calcium concentration within the normal physiologic range for musculoskeletal health. Vitamin D deficiency in children causes rickets and prevents children from reaching their maximum bone mass and genetically determined height. In adults, vitamin D deficiency causes abnormal mineralization of the collagen matrix in bone, known as osteomalacia. Usually the Survivors of critical illness are at risk for subsequent hospitalization, outpatient evaluation, and related health care costs. Moreover, recent studies showed that vitamin D deficiency among critically ill patients increased the rate of mortality. Therefore, this paper desired to determine the vitamin D-3 status according to demographic characteristics of critically ill patients admitted at ICU with multidisciplinary diseases.

Objective: The aim of this paper was to determine the vitamin D-3 status according to demographic characteristics of critically ill patients admitted at ICU with multidisciplinary diseases.

Methodology: This was a descriptive cross-sectional study conducted at the Intensive Care Unit (ICU) in Shaheed Monsur Ali Medical College and Hospital, Uttara Dhaka, Bangladesh during July, 2023 to October, 2023. A total of 243 critically ill patients admitted at ICU with multidisciplinary diseases were purposively enrolled in this study. An international standard approach was used to determine the vitamin D-3 level of the study patients. The collected data were analyzed using Statistical Package for Social Sciences (SPSS) software, version 23.0. The ethical clearance of this study was obtained from the Ethics Committee of Shaheed Monsur Ali Medical College and Hospital, Uttara Dhaka, Bangladesh.

Results: A total of 243 critically ill patients at any age admitted at ICU with multidisciplinary diseases were enrolled in this study. Among the patients, 11(4.52%) were children and 232(95.47%) were adults. Among the children, male were 7(63.63%) and female were 4(36.36%) while in the adults, male were 123(53. 1%) and female were 109(46.98%). Among the children, 9(81.81%) were from urban area while 2(18.18%) children were from rural area of Bangladesh. Among the adults, 145(62.5%) were from urban area and 87(37.5%) were from rural area of Bangladesh. The mean age of the study patients was 46.55±19.60 years. In the adults, the vitamin D-3 level were observed deficiency 208(89.66%), insufficiency 18(7.75%), sufficiency 6(2.58%) and there was no toxicity and the most deficiency prevalent age group (38-57) years. In the male adults, the vitamin D-3 level were observed 111(47.84%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency while among the female adults, 97(41.81%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency and there

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Citation: Mohammad Mostafizur Rahman, Kazi Jahangir Hossain, Mohammad Farhadul Haque, Nasir Uddin Ahmed, Momena Begum, Muhammad Salah Uddin, Shouhardyo Kundu, Sukalyan Kumar Kundu. Vitamin D-3 Status of Critically Ill Patients Admitted at ICU with Multidisciplinary Diseases in a Tertiary Care Hospital. Fortune Journal of Health Sciences. 7 (2024): 243-249.

Received: February 25, 2024
Accepted: April 03, 2024
Published: May 07, 2024

Rahman MM, et al., Fortune J Health Sci 2024
DOI:10.26502/fjhs.183

was no toxicity in both the gender. According to residence distribution, the urban adults had 129(55.68%) deficiency, 11(4.74%) insufficiency and 5(2.15%) sufficiency while in rural adults had 79(34.05%) deficiency, 7(3.01%) insufficiency, 1(0.43%) sufficiency and no toxicity was observed among the urban and rural adults. Among the children, 6(54.54%) had deficiency and followed by 5(45.45%) insufficiency and 0(0%) sufficiency. The most vitamin D-3 deficiency prevalent child age group was (14-17) years. Among the male children, 4(36.36%) had deficiency, and followed by 3(27.27%) insufficiency and 0(0%) sufficiency while in female children, 2(18.18%) had deficiency, 2(18.18%) insufficiency and 0(0%) sufficiency. 5(45.45%) urban children had deficiency, 4(36.36%) insufficiency and 0(0%) sufficiency while 1(9.09%) rural children had deficiency, 1(9.09%) insufficiency and 0(0%) sufficiency.

Conclusion: This study investigated 89.66% critically adult ill patients at ICU had vitamin D-3 deficiency and at the same time 54.54% critically ill children admitted at ICU had vitamin D-3 deficiency which may increase the rate of mortality. So, this study emphasises on vitamin D-3 status investigation and thereby its supplementation for the critically ill patients at ICU to decrease the rate of mortality in Bangladesh.

Keywords: Vitamin D-3 status, Critically ill patients, intensive care unit, Admitted, Tertiary care hospital

Introduction

Vitamin D is labeled as the "sunshine vitamin" because it is produced in the skin upon exposure to the sun. Vitamin D is necessary to maintain serum calcium concentration within the normal physiologic range for musculoskeletal health [1]. The Endocrine Society, the National and International Osteoporosis Foundation and the American Geriatric Society define vitamin D deficiency as a 25-hydroxyvitamin (25 OH D) level below 30 ng/mL. The Endocrine Society recommends a preferred range of 40 to 60 ng/mL [2, 3]. Vitamin D deficiency in children causes rickets and prevents children from reaching their maximum bone mass and genetically determined height. In adults, vitamin D deficiency causes abnormal mineralization of the collagen matrix in bone, known as osteomalacia. This collagen matrix is weak, does not provide production. Ultraviolet B (UVB) adiation, wavelength (290 to 315 nm) converts 7- dehydrocholesterol in the skin to provitamin D. [4,5] This provitamin D undergoes isomerization by heat and is converted to vitamin D. Vitamin D from skin and diet is metabolized in the liver to 25-hydroxyvitamin D (25 OH D), and 25-hydroxyvitamin D is useful for assessing vitamin D status [5].

In the 1950s and 1960s, when the field of critical care developed, the primary focus was on survival: taking a patient who was dying imminently, providing vital organ support with infusions and pharmaceutical machines, and saving the patient from the agony of death [5,6]. Currently one in five Americans dies in the ICU, and virtually all of today's generation will have an ICU encounter during their lifetime. Survivors of critical illness are at risk for subsequent hospitalization, outpatient evaluation, and related health care costs [6, 7] It is therefore appropriate to undertake this work in order to provide current and accurate information on the functions of vitamin D, what its deficiency entails and its impact on health and its role as a risk factor for mortality in critically ill patients. The non-skeletal actions of vitamin D are mediated by the control of gene expression in a number of organs such as brain, prostate, colon and immune cells, which may be of particular relevance in critical illness [8].

These non-skeletal actions result in the regulation of cell proliferation, differentiation, apoptosis and angiogenesis. In fact, the mechanism of action of vitamin D in these contexts is analogous to the way steroid hormones act. As a result of this contemporary knowledge, vitamin D is considered more of a hormone than a vitamin. We can see other functions of vitamin D found in animal models. [9]. Several population studies have shown that low vitamin D levels are associated with poor outcomes. However, causality is more difficult to establish given that a low vitamin D level itself could be a marker of poor general health and deficiency is seen in people with limited physical activity and little exposure to sunlight, advanced age, obesity, poor diet, and other comorbid diseases [10]. In the general population, mortality risk appears to decrease with increasing 25 hydroxy-D levels, with optimal levels of 75 to 87.5 nmol/l. A large meta-analysis of community dwelling adults showed that the lowest observed 25-hydroxy-D quintile was associated with increased mortality [11]. Conditions that have been associated with vitamin D deficiency include certain malignancies such as colon, breast, ovarian, prostate, and lymphoma. Some studies also report an increased risk of mortality with these cancers in people with vitamin D deficiency [12]. Therefore, the aim of this paper was to determine the vitamin D-3 status according to demographic characteristics of critically ill patients admitted at ICU with multidisciplinary diseases.

Objectives

General Objective

- To determine vitamin D-3 status of critically ill patients admitted at ICU with multidisciplinary diseases**.**

Specific Objectives

- To identify the socio-demographic characteristics of critically ill patients admitted at ICU with multidisciplinary diseases.

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- To know the diagnosis status of the study patients.
- To determine vitamin D-3 status of the adult patients according to their socio-demographic characteristics.
- To determine vitamin D-3 status of the child patients according to their socio-demographic characteristics

Methodology

This was a descriptive cross-sectional study conducted at the Intensive Care Unit (ICU) in Shaheed Monsur Ali Medical College and Hospital, Uttara Dhaka, Bangladesh during July, 2023 to October, 2023. The purpose, benefits and risks of this study were disclosed to legal guardians of the patients in local language. Then written informed consent was obtained from the legal guardians of the patients. A purposive random sampling technique was used and a total of 243 critically ill patients who were admitted in ICU with multidisciplinary diseases at any age were enrolled in this study. Blood samples for laboratory measurements of serum 25 (OH) D were collected on patients' admission (4 ml), which were then immediately transferred to the endocrinology laboratory. Serum 25 (OH) D was measured using a radioimmunoassay kit technique using the 12 well gamma Counter machine (STRATEC, Birkenfeld, Germany). Till the samples were not processed, they were stored at-20°C temperature after separating the serum. Vitamin D-3 deficiency was defined as values (<20 ng/mL) and followed by insufficiency (20-30 ng/mL), sufficiency (30-100 ng/mL) and toxicity (>100ng/mL) for the adults as well as deficiency was identified as values (<15 ng/mL) and followed by insufficiency (15-20 ng/mL) and sufficiency (20-100 ng/mL) for the child. Severity of critical illness was assessed by admission acute physiological and chronic health evaluation (APACHE II) score and sequential organ failure assessment (SOFA) score. The data were collected through a Case Record Form (CRF). The collected data were cleaned, edited and entered into computer for analysis. The data were analyzed using Statistical Package for Social Sciences (SPSS) software, version 23.0. Descriptive statistical analyses were performed to determine the demographic characteristics of the study patients. Then crosstabs were performed to determine the severity of vitamin D-3 level according to demographic characteristics of the study patients and the results were presented as frequency and percentage in tables and charts. The ethical clearance of this study was obtained from the Ethics Committee of Shaheed Monsur Ali Medical College and Hospital, Uttara Dhaka, Bangladesh. The inclusion and exclusion criteria of this study were as follows:

Inclusion criteria

- Age: Any
- Having legal guardian
- Legal guardian agreed to provide informed consent

Exclusion criteria

- Having no legal guardian
- Legal guardian refused to provide informed consent
- Acute critically ill patients

Results

Table 1: Age distribution of the study patients (n=243)

Age groups (years)	Frequency	Percent
<17	11	4.5
18-37	77	31.7
38-57	79	32.5
58-77	63	25.9
>78	13	5.3
Total	243	100
Mean ±SD (years)	46.55±19.60	
Median	45	
Mode	46	
Range	Aug-95	

Table 1 shows the age distribution of the study patients. Among the study patients, the majority 79(32.5%) belonged to the age group (38-57) years and followed by 77(31.7%), (18-37) years, 63(25.9%), (58-77) years,13(5.3%), (>78) years and 11(4.5%), (<17) years. The mean age of the study patients was 46.55±19.60 years and followed by median 45 years, mode 46 years and range 8-95 years.

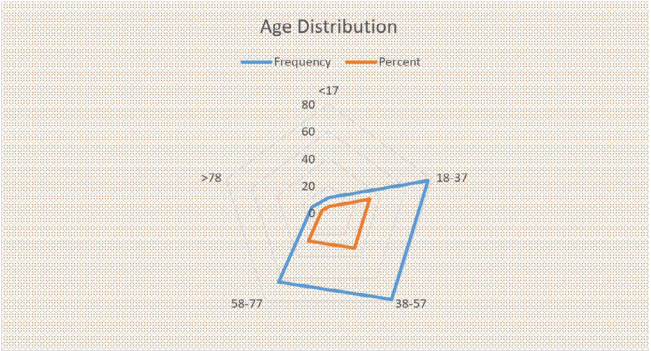

Figure 1: Age distribution of the study patients (n=243).

Table 2: Sex distribution of the study patients (n=243).

Sex	Frequency	Percent
Male	130	53.5
Female	113	46.5
Total	243	100

Table-2 shows the Sex distribution of the study patients. Among the study patients, the maximum 130(53.5%) were male and 113(46.5%) were female.

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Table-3 shows the residence distribution of the study patients. Among the study patients, the maximum 154(63.4%) were from urban area and 89(36.6%) were from rural area of Bangladesh.

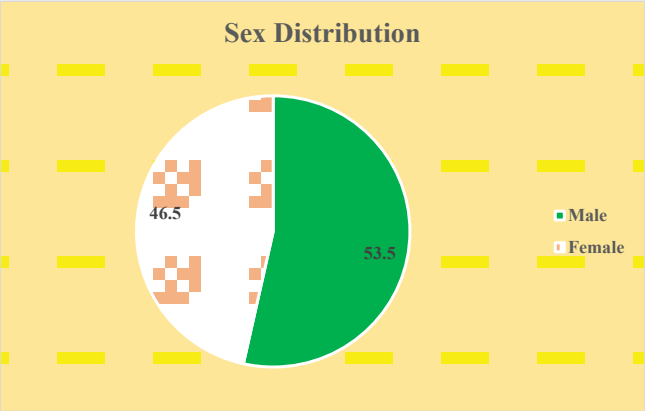

Figure 2: Sex distribution of the study patients (n=243).

Table 3: Residence distribution of the study patients (n=243).

Frequency	Frequency	Percent
Urban	154	63.4
Rural	89	36.6
Total	243	100

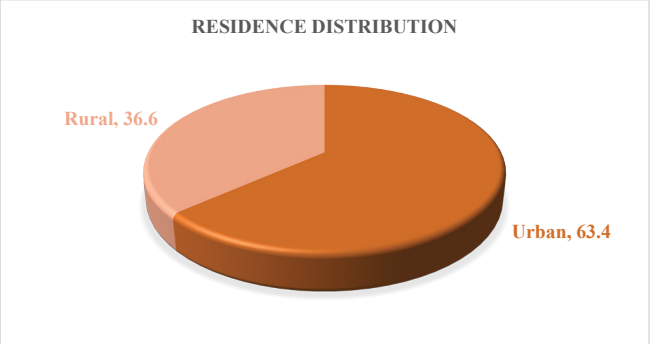

Figure 3: Residence distribution of the study patients (n=243).

Table-4 shows the distribution of vitamin D-3 level by demographic characteristics of the adult study patients. According to the age distribution of the adults, in the age group (18-37) years, the distribution of vitamin D-3 level being observed 7(3.01%) deficiency, 5(2.15%) insufficiency and 0(0%) sufficiency. In the age group (38-57) years, the distribution of vitamin D-3 level were being observed 72(31.03%) deficiency, 4(1.72%) insufficiency and sufficiency 3(1.29%). According to the age group (58-77) years, the distribution of vitamin D-3 level was being observed 53(22.84%) deficiency, 8(3.44%) insufficiency and 2(0.86%) sufficiency. According to the age group >78 years, the distribution of vitamin D-3 level was being observed 11(4.74%) deficiency, 1(0.43%) insufficiency and 1(0.43%) sufficiency. Among the adult study patients, the total vitamin D-3 level were observed deficiency 208(89.66%) followed by insufficiency 18(7.75%), sufficiency 6(2.58%) and no toxicity was observed. Among the male adults, the distribution of vitamin D-3 level was being observed 111(47.84%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency while among the female adults, the distribution of vitamin D-3 level was being observed 97(41.81%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency and no toxicity was observed both in male and female adults. According to residence distribution, the distribution of vitamin D-3 level among urban study patients were being observed 129(55.68%) deficiency, 11(4.74%) insufficiency and 5(2.15%) sufficiency while in rural study patients, the distribution of vitamin D-3 level was being observed 79(34.05%) deficiency, 7(3.01%) insufficiency, 1(0.43%) sufficiency and no toxicity was observed among the urban and rural adults.

Table-5 shows the distribution of vitamin D-3 level by demographic characteristics of the child study patients. According to the child age group <8 years, the distribution of vitamin D-3 level was being observed 0(0%) deficiency, 1(9.09%) insufficiency and 0(0%) sufficiency. According to the age group (9-13) years, the distribution of vitamin D-3 level were being observed 2(18.18%) deficiency, 0(0%) insufficiency and 0(0%) sufficiency. According to the age group, (14-17) years, the distribution of vitamin D-3 level was being observed 4(36.36%) deficiency, 4(36.36%) insufficiency and 0(0%) sufficiency. Among the total child age group, the distribution of vitamin D-3 level being observed 6(54.54%) deficiency, 5(45.45%) insufficiency and 0(0%) sufficiency. Among the male study children, the distribution of vitamin D-3 level was being observed 4(36.36%) deficiency, 3(27.27%) insufficiency and 0(0%) sufficiency while in female children, the distribution of

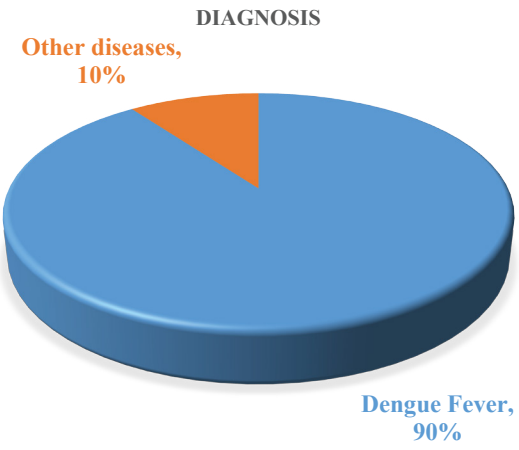

Figure 4: Diagnosis distribution of the study patients (n=243).

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Table 4: Distribution of Vitamin D-3 level by demographic characteristics of the adult patients (n=232).

Demographic Characteristics	Vitamin D-3 level of the adult study patients				Total N(%)
	<20 ng/mL (Deficiency) n(%)	20-30 ng/mL (Insufficiency) n(%)	30-100 ng/mL (Sufficiency) n(%)	>100ng/mL (Toxicity) n(%)	
Age(years)					
18-37	7(3.01)	5(2.15)	0(0)	0(0)	12(5.17)
38-57	72(31.03)	4(1.72)	3(1.29)	0(0)	79(34.05)
58-77	53(22.84)	8(3.44)	2(0.86)	0(0)	65(28.01)
>78	11(4.74)	1(0.43)	1(0.43)	0(0)	13(5.60)
Total	208(89.66)	18(7.75)	6(2.58)	0(0)	232(100)
Sex					
Male	111(47.84)	9(3.87)	3(1.29)	0(0)	123(53.01)
Female	97(41.81)	9(3.87)	3(1.29)	0(0)	109(56.98)
Total	208(89.66)	18(7.75)	692.58)	0(0)	232(100)
Residence					
Urban	129(55.68)	11(4.74)	5(2.15)	0(0)	145(62.5)
Rural	79(34.05)	7(3.01)	1(0.43)	0(0)	87(37.5)
Total	208(89.66)	18(7.75)	6(2.58)	0(0)	232(100)

Table 5: Distribution of Vitamin D-3 level by demographic characteristics of the child patients (n=11).

Demographic Characteristics	Vitamin D-3 Level			Total N(%)
	<15 ng/mL (Deficiency) N(%)	15-20 ng/mL (Insufficiency) (N%)	20-100 ng/mL (Sufficiency) N(%)	
Age(years)				
<8	0(0)	1(9.09)	0(0)	1(9.09)
9-13	2(18.18)	0(0)	0(0)	2(18.18)
14-17	4(36.36)	4(36.36)	0(0)	8(72.72)
Total	6(54.54)	5(45.45)	0(0)	11(100)
Sex				
Male	4(36.36)	3(27.27)	0(0)	7(63.63)
Female	2(18.18)	2(18.18)	0(0)	4(36.36)
Total	6(54.54)	5(45.45)	0(0)	11(100)
Residence				
Urban	5(45.45)	4(36.36)	0(0)	9(81.81)
Rural	1(9.09)	1(9.09)	0(0)	2(18.18)
Total	6(54.54)	5(45.45)	0(0)	11(100)

vitamin D-3 level was being observed 2(18.18%) deficiency, 2(18.18%) insufficiency and 0(0%) sufficiency. Among the urban study children, the distribution of vitamin D-3 level was being observed 5(45.45%) deficiency, 4(36.36%) insufficiency and 0(0%) sufficiency while among the rural study children, the distribution of vitamin D-3 level was being observed 1(9.09%) deficiency, 1(9.09%) insufficiency and 0(0%) sufficiency.

Discussion

The pandemic of vitamin D deficiency even in effluent societies has pointed out the growing distance of human race from nature. Recent research has generated interest in pleiotropic actions of vitamin D all over the world. Vitamin D receptors are found in nearly all types of immune cells [13]. Its action on innate immunity is stimulatory, while its action on adaptive immunity is mainly considered to be modulatory

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[14]. Various clinical studies and trials have shown correlation between vitamin D and systemic infections. Its deficiency has been associated with acute respiratory tract infections [15,16], cardiovascular diseases and other chronic illnesses [17]. Therefore, the researcher has designed this current study. This prospective cross-sectional study was conducted at ICU of Shaheed Monsur Ali Medical College and Hospital, Uttata, Dhaka, Bangladesh. The aim of this present study was to determine vitamin D-3 status of critically ill patients admitted at ICU with multidisciplinary diseases and were enrolled a total of 243 critically ill patients admitted at ICU with multidisciplinary diseases. Among the patients, 11(4.5%) were children and 232(95.47%) were the adults. Among the children, male were 7(63.63%) and female were 4(36.36%) while in the adults, male were 123(53.01%) and female were 109(46.98%). Among the children, 9(81.81%) were from urban area while 2(18.18%) children were from rural area of Bangladesh. Among the adults, 145(62.5%) were from urban area and 87(37.5%) were from rural area of Bangladesh. This current study observed the mean age of the admitted patients at ICU 46.55±19.60 years. These findings of this current study are persistent with some other studies [18-20]. Among the adult study patients, this study observed vitamin D-3 deficiency 208(89.66%), insufficiency 18(7.75%), sufficiency 6(2.58%) and there was no toxicity. Among the male adults, the distribution of vitamin D-3 level was being observed 111(47.84%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency while among the female adults, the distribution of vitamin D-3 level was being observed 97(41.81%) deficiency, 9(3.87%) insufficiency and 3(1.29%) sufficiency .and there was no toxicity in both male and female adults. According to residence distribution, the distribution of vitamin D-3 level among urban study patients were being observed 129(55.68%) deficiency, 11(4.74%) insufficiency and 5(2.15%) sufficiency while in rural study patients, the distribution of vitamin D-3 level was being observed 79(34.05%) deficiency, 7(3.01%) insufficiency, 1(0.43%) sufficiency and there was no toxicity among the urban and rural adults. These findings of our study prevailed; the urban adults' male patients are the worst sufferers of vitamin D-3 deficiency. This may be happened due to their limited movement in the sunlight or other issues. These findings of our study are almost similar to another study conducted in north India on the title 'Prevalence of vitamin D deficiency in critically ill patients and its influence on outcome: experience from a tertiary care centre' by Yadav, S. et al, (2013). In their study, they observed 80.4% vitamin D deficiency among 127 critically ill study patients [21]. Our study finally observed, among the children study patients, 6(54.54%) deficiency, 5(45.45%) insufficiency and 0(0%) sufficiency and among the male study children, 4(36.36%) deficiency, 3(27.27%) insufficiency and 0(0%) sufficiency while in female children, 2(18.18%) deficiency, 2(18.18%) insufficiency and 0(0%) sufficiency as well as among the urban study children, 5(45.45%) deficiency, 4(36.36%) insufficiency and 0(0%) sufficiency while among the rural study children,1(9.09%) deficiency, 1(9.09%) insufficiency and 0(0%) sufficiency. These findings of our study prevailed the urban children are the worst victim to vitamin D deficiency than the rural children because the rural children may have more activities under sunlight than the urban children. These findings of our study are persistent with another study conducted in Korea in 2016 by Roh et al. In their study, they observed, among 195 study children, 59.1% suffered from vitamin D deficiency [22]. However, the findings of this present study hope to be a great use to the physicians, clinicians as well the policymakers of Bangladesh to maintain and manage the critically ill patients admitted at ICU.

Conclusion

This study investigated 89.66 % critically ill adult patients at ICU had vitamin D-3 deficiency and at the same time 54.54% critically ill children admitted at ICU had vitamin D-3 deficiency which may increase the rate of mortality. So, this study emphasises on vitamin D3 status investigation and thereby its supplementation for the critically ill patients at ICU to decrease the rate of mortality in Bangladesh.

Limitations of the Study

This was a single centre study with limited data of purposive sampling technique. Therefore, the results of this study may not reflect the whole country.

Recommendations

To justify the results of this study a multi-centered study may be conducted across the country with a large calculated sample size.

Funding: Self-funding

Conflict of Interest: None declared

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Citation: Mohammad Mostafizur Rahman, Kazi Jahangir Hossain, Mohammad Farhadul Haque, Nasir Uddin Ahmed, Momena Begum, Muhammad Salah Uddin, Shouhardyo Kundu, Sukalyan Kumar Kundu. Vitamin D-3 Status of Critically Ill Patients Admitted at ICU with Multidisciplinary Diseases in a Tertiary Care Hospital. Fortune Journal of Health Sciences. 7 (2024): 243-249.