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Full Length Research Paper

# The determinants of the adoption behaviour of women azolla (*Azolla pinnata*) farmers in Coochbehar District of West Bengal

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Adoption behaviour may be reflected as the predisposition of the behaviour of an individual during the adoption process of any innovation. Here, in the present study, the respondents were women stakeholders selected through panchayat. The study analysed their adoption behaviour towards azolla cultivation because the scientific azolla cultivation has been taken up as the innovation in terms of which the adoption percentage and behaviour was calculated for the present study. The study was conducted in five villages of Coochbehar-II block of Coochbehar district in West Bengal. Purposive sampling procedure was followed in the selection of the district, the blocks and also for the gram panchayats and random sampling procedure was followed in the selection of the villages and respondents in the present study. The adoption percentage was considered as the dependent variable and the other attributes of women stakeholders were considered as the independent variables for the study. The data were collected with the help of structured questionnaire schedule through personal interview method. The statistical methods used for the analysis of the data were co-efficient of correlation and multiple regressions. In the present study, it was found that the attributes like expenditure and knowledge about the technology are positively and significantly associated with the dependent variable and the attribute caste is significantly but negatively associated with the dependent variable, that is, adoption percentage of the women azolla growers. Results also showed that the variable annual income of the respondents is contributing negatively and significantly in case of characterizing the adoption percentage of the women azolla farmers. The  $R^2$  value being 0.719, it is to infer that the sixteen predictor variables put together have explained 71.90% variation embedded with the predicted variable, adoption percentage.

**Key words:** Adoption behaviour, women stakeholders, panchayat, azolla cultivation.

## INTRODUCTION

In the changed declared hegemony of the climate, the concept of adaptation is becoming more resilient day by day in global context. The connotation of adaptation can be achieved with the help of analyzing the adoption

behaviour of technology user. Nowadays, the technology associated with the locally available resources is much more impactful in case of delineating the socio-economic and livelihood improvement of the local people. The



people are mostly relying upon the technology which are cost effective, ecologically sound, simple in technology belongingness and economically profitable. The adoption behaviour of any individual is very complex in nature comprising number of successive stages starting from first hearing about an innovation to final adoption. When assessing farmers' technology adoption behaviour, the methodology has to consider a number of inter-related factors such as the policy framework for farmers, the availability of technical information and the farmers' perceptions, beliefs and motives (Beedell et al., 2000). Social scientists investigating farmers' adoption behaviour has accumulated considerable evidence showing that demographic variables, technology characteristics, information sources, knowledge, awareness, attitude and group influence affect adoption behaviour (Oladele, 2005). Therefore, all agricultural development schemes and intervention programs in the study area should focus more on factors affecting adoption behaviour of farmers in order to encourage adoption and sustain the use of agricultural innovations (Tsado, 2008). So, it may be realized that the improvement of adoption process regarding a particular fruitful technology may empower the rural people through improving their livelihood and socio-economic situation. Not only that but also for all around development of a household needs to be refocused on the economic empowerment of the farm women through women-friendly technology. But, due to limitation in horizontal expansion of land and agriculture, the only alternative left is vertical expansion through various farm enterprises requiring less space and time. A combination of agriculture and livestock could be a possible option for this purpose because most of the farm families have domestic dairy cattle and through selling of their cattle's milk, they can have an alternative source of income. But, the shortage of fodder due to ever decreasing area under cereals and fodder crops is getting compensated with increased use of commercial cattle feed, resulting in increased costs of milk production (Reddy, 2007). Therefore, livestock rearing is becoming less profitable. This problem can effectively be countered through introduction of azolla in the cattle feed because of its nutritional value and low cost. During the study for promoting livelihoods through dairy farming under the Orissa Watershed Development Mission (2011), it was found that dairy farmers who have too little land for fodder production can take up Azolla technology as it can be cheaply produced (at Rs.0.65/ kg of Azolla) in good quantities and be used as a cheap and nutritious cattle feed and also the cost of production of Azolla is much lower in comparison to other green fodders. In another

study, it was observed that due to its high nutritional values and protein content, Azolla is suitable for human consumption and as feed supplement for variety of animals like fish, ducks, cattle, poultry etc. to reduce feed cost (Raja et al., 2012). Azolla is the most economic and efficient feed substitute for live stock which is very rich in proteins, essential amino acids, vitamins, growth promoter intermediaries and minerals like calcium, phosphorus, potassium, ferrous, copper, magnesium etc. (Lakshmi et al., 2012). All these bio-chemical constitutions of azolla and its rapid multiplication rate make azolla ideal organic feed substitutes for livestock (Biswas et al., 2013). Azolla can serve as a potential green feed supplement for the dairy cattle for the improvement in productive performance especially where/when green fodder availability is scanty (Chatterjee et al., 2013). A trial carried with azolla as feed substitute shows that there is an overall increase in milk production by 15 to 20% by supplementing feed with the same quantity of the plant on dry weight basis without affecting milk production (Benjamin, 2012). In a project for the development of disadvantaged areas of Bidar District (India), azolla production for increasing output from dairying was found to have the second highest benefit:cost ratio after production of worms for vermicomposting (Deshmukh et al., 2013). Besides all these things, azolla has some environmental benefits like it can serve as a candidate for the bioremediation of waste waters and effluents because it can accumulate excessive amounts of pollutants such as heavy metals, radio nuclides, dyes, pesticides, etc. (Sood et al., 2012). Therefore, in the present study, azolla cultivation has been taken up as the technology for assessing how easily it can be handled by the women and also its profitability.

Keeping all these in view, the present study constructed to analyze the adoption behaviour of the women stakeholders selected through panchayat and to identify the factors contributing towards their adoption behaviour for azolla cultivation.

## METHODOLOGY

The present study was conducted in five villages namely Jatrapur, Jibdharer Kuthi and Kaminir Ghat in Takargach-Rajarhat Gram Panchayat and Raserkuthi, Khairatibari villages in Dhandhinguri Gram Panchayat under the block Cooch Behar-II of Cooch Behar district in West Bengal. Purposive and random sampling procedures were followed for the selection of the respondents. The adoption percentage is considered as the dependent variable and the sixteen other attributes of the women stakeholders were considered as the independent variables for the study. The data were collected with

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the help of structured interview schedule through personal interview method. The collected data were processed with statistical tools like co-efficient of correlation and multiple regressions. The scientific azolla cultivation was the selected practice in terms of which the adoption percentage and behavior was calculated for the present study.

## RESULTS AND DISCUSSION

Table 1 presents the distribution of the women stakeholders selected through panchayat in Terai region of West Bengal according to their selected attributes. The results show that the age of the respondents ranges from 24 to 55 years. The mean score of the total distribution, age is 35.74 and standard deviation of the distribution is 8.80. The coefficient of variation value within the distribution 24.62% signifies the high consistency level of the distribution for the variable 'age'. The education of the respondents ranges from illiterate to class three. The mean score of the total distribution, education is 1.26 and standard deviation of the distribution is 0.81. The coefficient of variation value within the distribution 64.29% signifies the medium consistency level of the distribution for the variable 'education'. The variable caste of the respondent ranges from scores 2 to 3 means the caste schedule caste and other backward caste. The mean score of the total distribution, caste is 2.87 and standard deviation of the distribution is 0.34. The coefficient of variation value within the distribution 11.85% signifies the high consistency level of the distribution for the variable 'caste'. The variable primary occupation of the respondents ranges from score 1 to 3 means from agricultural labour to business group. The mean score of the total distribution, primary occupation is 2.13 and standard deviation of the distribution is 1.29. The coefficient of variation value within the distribution 60.56% signifies the medium consistency level of the distribution for the variable 'primary occupation'. The variable family size of the respondent ranges from scores 2 to 7 means the two members' family to seven members' family. The mean score of the total distribution, family size is 4.87 and standard deviation of the distribution is 1.14. The coefficient of variation value within the distribution 23.40% signifies the high consistency level of the distribution for the variable 'family size'. The variable educational aspiration of the respondents ranges from scores 4 to 10. The mean score of the total distribution, educational aspiration is 6.04 and standard deviation of the distribution is 1.64. The coefficient of variation value within the distribution 27.15% signifies the high consistency level of the distribution for the variable 'educational aspiration'. The variable farm size of the respondent ranges from scores 0 to 10.25 means landless to 10.25 bighas of land. The mean score of the total distribution, farm size is 1.47 and standard deviation of the distribution is 2.57. The coefficient of variation value within the distribution 174.83% signifies the very poor consistency level of the

distribution for the variable 'farm size'. The variable annual income of the respondent ranges from scores 10 to 72 means Rs. 10000 to Rs 72000. The mean score of the total distribution, annual income is 36.09 and standard deviation of the distribution is 17.90. The coefficient of variation value within the distribution 49.60% signifies the medium consistency level of the distribution for the variable 'annual income'. The variable house type of the respondents ranges from scores 1 to 2 means kachha house to mixed house. The mean score of the total distribution, house type is 1.09 and standard deviation of the distribution is 0.29. The coefficient of variation value within the distribution 26.60% signifies the high consistency level of the distribution for the variable 'house type'. The material possession of the respondents ranges from scores 1 to 10 means the little material to very good amount of material. The mean score of the total distribution, material possession is 2.87 and standard deviation of the distribution is 2.74. The coefficient of variation value within the distribution 95.47% signifies the very poor consistency level of the distribution for the variable 'material possession'. The animal size of the respondents ranges from score 1 to 5 means one number to five numbers. The mean score of the total distribution, animal size is 2.65 and standard deviation of the distribution is 0.98. The coefficient of variation value within the distribution 36.98% signifies the high consistency level of the distribution for the variable 'animal size'. The expenditure of the respondents ranges from score 0.60 to 8.40 means Rs. 600 to Rs 8400. The mean score of the total distribution, expenditure is 4.06 and standard deviation of the distribution is 2.42. The coefficient of variation value within the distribution 59.61% signifies the medium consistency level of the distribution for the variable 'expenditure'. The risk orientation of the respondents ranges from score 27 to 42 means low risk orientation to medium risk orientation. The mean score of the total distribution, risk orientation is 35.48 and standard deviation of the distribution is 3.42. The coefficient of variation value within the distribution 9.64% signifies the very high consistency level of the distribution for the variable 'risk orientation'. The knowledge about the technology of the respondents ranges from score 7 to 13 means low knowledge to medium knowledge. The mean score of the total distribution, knowledge is 10.83 and standard deviation of the distribution is 1.59. The coefficient of variation value within the distribution 14.68% signifies the very high consistency level of the distribution for the variable 'knowledge'. The attitude towards the technology adoption of the respondents ranges from score 38 to 52 means medium to high positive attitude towards adoption. The mean score of the total distribution, attitude is 41.52 and standard deviation of the distribution is 2.86. The coefficient of variation value within the distribution 6.40% signifies the very high consistency level of the distribution for the variable 'attitude'. The assessed training need of

**Table 1.** Distribution of the women stakeholders selected through Panchayat according to the attributes.

Variables	Range	Mean	SD	CV (%)
Age	24-55	35.74	8.80	24.62
Education	0-3	1.26	0.81	64.29
Caste	2-3	2.87	0.34	11.85
Primary occupation	1-4	2.13	1.29	60.56
Family Size	2-7	4.87	1.14	23.40
Educational aspiration	4-10	6.04	1.64	27.15
Farm size	0-10.25	1.47	2.57	174.83
Annul Income	10-72	36.09	17.90	49.60
House Type	1-2	1.09	0.29	26.60
Material Possession	1-10	2.87	2.74	95.47
Animal Size	1-5	2.65	0.98	36.98
Expenditure	0.60-8.40	4.06	2.42	59.61
Risk Orientation	27-42	35.48	3.42	9.64
Knowledge about the technology	7-13	10.83	1.59	14.68
Attitude towards technology adoption	38-52	41.52	2.66	6.40
Training need assessed	4-7	5.48	1.04	18.98
Adoption percentage	0-90	57.83	30.29	52.38

the respondents ranges from score 4 to 7 means four numbers to seven numbers of training need. The mean score of the total distribution, assessed training need is 5.48 and standard deviation of the distribution is 1.04. The coefficient of variation value within the distribution 18.98% signifies the high consistency level of the distribution for the variable 'assessed training need'. The adoption percentage of the respondents ranges from score 0 to 90 means from very low to very high level of technology adoption. The mean score of the total distribution, adoption is 57.83 and standard deviation of the distribution is 30.29. The coefficient of variation value within the distribution 52.38% signifies the medium consistency level of the distribution for the variable 'adoption percentage'.

Table 2 presents the Pearson's co-efficient of correlation among the adoption percentage of the women stakeholders selected by panchayat with sixteen causal variables. The result shows that the variable caste is negatively and significantly associated with the adoption percentage and the variables expenditure and knowledge about the technology are positively and significantly associated with the adoption percentage at 5% level of significance.

### Caste and adoption percentage

The adoption of scientific azolla cultivation practices was higher in case of low-caste households. Abundance of family labour force, dependency on domestic animals and small farms and diminishing trend of employment in traditional professions of low-caste households are some of the major reasons for their higher adoption of scientific

azolla cultivation practices. In the case of high-caste households one of the main reasons behind the low rate of improved scientific azolla cultivation practices is their better access to land that reduces their need to invest in their domestic animals rearing which is less productive. Other reasons are higher involvement of their children in the schools outside the village and increasing family labour shortages and their resource richness. Low-caste households on average are poorer than high-caste households both in terms of income and major assets like land holding. That is why the variable caste is negatively and significantly associated with the adoption percentage.

### Expenditure and adoption percentage

Expenditure accurately depicts the investment for applying any technology in the real life situation. Always expenditure bears the cost for taking risk in application of technology. In other words application of technology occurs after the mental decision to adopt an innovation. In the present study the scientific azolla cultivation practices are adopted by the women stakeholders selected by the panchayat by incurring the expenditure to practice the scientific azolla cultivation throughout the year. That is why the variable expenditure is positively and significantly associated with the adoption percentage.

### Knowledge about the technology and adoption percentage

Knowledge of the individual may be the cognitive pursuit

**Table 2.** Correlation coefficient of adoption with sixteen independent attributes of women stakeholders selected by Panchayat.

Variables	Coefficient of correlation (r)
Age	-0.12
Education	-0.01
Caste	-0.40*
Primary occupation	-0.10
Family Size	-0.11
Educational aspiration	0.19
Farm size	-0.02
Annul Income	-0.29
House Type	0.18
Material Possession	0.08
Animal Size	0.06
Expenditure	0.37*
Risk Orientation	0.27
Knowledge about the technology	0.42*
Attitude towards technology adoption	-0.09
Training need assessed	0.27

\*Significant at 5% level.

to increase the wisdom of the individual. Knowledge always tries to help the individual to develop their mind set for analysing the pros and cons of the technology. Such pros and cons help an individual to take any decision in favour of the technology. Not only that but also it increases the exposure of an individual regarding the outer sphere for horizontal expansion of any innovation. In the present study the better knowledge about the scientific azolla cultivation of the women stakeholders selected by panchayat helps to adopt the technology in their own situation to use the azolla as the low cost supplementary feed for the cattle. The knowledge of the women stakeholders developed with the help of the training imparted by the Coochbehar KVK personnel. That is why the variable knowledge is positively and significantly associated with the adoption percentage.

Table 3 reflects the multiple regression analysis of the predicted variable, that is, adoption percentage with sixteen predictor variables of the women stakeholders selected by the panchayat. From the table it is observable that the variable annual income is negatively and significantly contributing towards characterizing the adoption percentage at 13% level of significance.

### Annual income and adoption percentage

Annual income is the economic indicator of an individual. It also helps to acquire respect and values in the society. The selected women are mostly economically deprived and have the capability to take risk for increasing their

earning in a successful manner. In the present study it is found that the high annual income women group are reluctant to adopt the practices for increasing the earning from household livestock enterprise. Consequently, the variable annual income is positively and significantly contributing in case of characterizing the adoption percentage. One unit change of the variable annual income is delineating the 1.85 unit change in the predicted variable, adoption percentage.

The  $R^2$  value being 0.719, it is to infer that the sixteen predictor variables put together have explained 71.90% variation embedded with the predicted variable adoption percentage. Still 29.10% variations embedded with predicted one are unexplained. Thus it would be suggested that inclusion of some more contextual variables possessing direct bearing on the adoption percentage could have increased the level of explicability.

Table 4 reveals that per day cost for cow feed with azolla for 2 cows was Rs.32/- whereas the per day cost for cow feed without azolla for 2 cows was Rs.41/- that means using cow feed with azolla made a profit of Rs.9/- per day.

Table 5 shows that milk production has increased to 20% and lastly, Table 6 represents a calculated profit of Rs.570/- per month from using azolla as cattle feed.

### Conclusion

In the changing dynamics of the social system, there is a need to consider the prerogative of the women farmers in decision making process in the inside (homestead activity)

**Table 3.** Multiple regression analysis in case of women stakeholders selected by Panchayat.

Variables	Regression coefficient	S.E.	t value
Age	-1.85054	2.13730	-0.87
Education	0.56135	22.59085	0.02
Caste	-3.75574	37.40452	-0.10
Occupation	7.94257	9.63717	0.82
Family size	8.22408	8.93816	0.92
Educational aspiration	3.18003	7.49169	0.42
Farm size	2.31277	4.87192	0.47
Annul Income	-1.84919	1.10985	-1.67\$
House Type	9.30615	46.70217	0.20
Material Possession	5.72304	5.79146	0.99
Animal Size	-1.57020	10.74542	-0.15
Expenditure	3.32712	4.91812	0.68
Risk Orientation	1.18008	4.05149	0.29
Knowledge about the Technology	9.67134	7.88939	1.23
Attitude towards technology adoption	4.08458	4.22401	0.97
Training need assessed	-0.88888	10.53165	-0.08

R<sup>2</sup>= 0.7186, \$ Significant at 13% level.

**Table 4.** Comparison of feed cost (Average feed cost/day/2 cows).

Feed items	Cow feed with Azolla			Cow Feed without Azolla		
	Quantity	Rate (Rs.)	Total amount(Rs.)	Quantity	Rate(Rs.)	Total amount (Rs.)
Paddy straw	8 bundles	2.00/bundle	16	10 bundles	2.00/bundle	20
Rice bran	3 kg	5.00/kg	15	4 kg	5.00/kg	20
Azolla	1.5 kg	-	-	-	-	-
Salt	200 g	5.00/Kg	1	200 g	5.00/Kg	1
Grasses	8 kg	-	-	8 kg	-	-
Total			32			41

**Table 5.** Comparison of milk yield (Average milk yield/day/ cow).

Cow feed with Azolla	Cow feed without Azolla	Percentage increase
2.40 L	2.00 L	20.00

**Table 6.** Comparison of monthly basis.

Cow feed without Azolla	Cow feed with Azolla	Profit
Feed monthly 41×30=1230	Feed monthly 32×30=960	1230-960=270
Milk production monthly 2LTR×30=60 L	Milk production monthly 2.40×30=72 L	1800-1500=300
Monthly income 60 L×25 Rs.=1500	Monthly income 72 L x 25 Rs.=1800	

(\*price of 1lit of milk = Rs.25/-)

and outside (agricultural activity) activity of the development process. In this direction, it is of prime

importance to know the adoption behaviour of the rural women before taking any new agricultural technology or

innovation to them with an intention to empower them by providing opportunities for sustainable livelihood. This can only be achieved by finding out the factors influencing their adoption behaviour. Besides this, as the income from cropping alone is insufficient to sustain farmers' family, a judicious mix of enterprises is recommended. Livestock rearing and selling of their milk is a very common phenomenon in the rural area besides cultivation to complement the farm income of farm families. In this context, azolla cultivation could pave its way by increasing the profit from livestock rearing because cow feed with azolla costs lesser than cow feed without azolla and also use of azolla as cow feed supplement increases the milk yield due to its nutritional value. Therefore, the present study has attempted to assess the determinants of the adoption behaviour of the rural women stakeholders for azolla cultivation because this livestock rearing is mainly managed by the farm women. It has been found that the variable knowledge about the technology has positive and significant relationship with the adoption behaviour while the family size of the rural women has been found to be negatively and significantly contributing towards characterizing the adoption percentage of the women stakeholders. Therefore, the variables stated above should be given major emphasis during planning and policy making to promote adoption of azolla cultivation by the farm women for making the livestock enterprise more profitable and sustainable which could lead to their socio-economic upliftment and empowerment to some extent and also to offer them with a sustainable livelihood.

### Conflict of Interests

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

## Femur neck insufficiency fracture in an adolescent associated with vitamin D deficiency

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**The study reports a case of 14-year-old female child who was not participating in any athletic activities, and presented with gradual onset of left side hip and groin pain since 8 months duration. Clinical and radiological evaluation showed medial-sided femur neck insufficiency fracture associated with vitamin D deficiency. Femur neck insufficiency fractures are rare entity in children; usually result from overuse injuries in athletes. Absence of athletic activities raises the suspicion of endocrine or metabolic derangement as an underlying cause of insufficiency fracture.**

**Key words:** Femur neck, insufficiency fracture, adolescent, vitamin D deficiency.

### INTRODUCTION

Stress fractures represent the inability of the bone to withstand the repeated load exerted from athletic activities or even normal daily life events on a normal or weakened bone, respectively. This repetitive load results in microdamage to the bone, which may progress and result in fracture; if the healing process does not proceed properly (Kaeding and Miller, 2013).

Stress fractures have different severity of structural changes and different potential for healing related to their location and etiology. Femur neck stress fractures are extremely rare in children with open proximal femoral physis, but should be included in the differential diagnosis of hip pain in children, in addition to synovitis, infection, slipped capital femoral epiphysis, Leg-Calves-Perthes disease and benign and malignant neoplasms (Er et al., 2014). All cases of femur neck stress fractures published

in the literature were either in athletes or in children participating in repetitive high impact activities (Er et al., 2014; Lehman and Shah, 2004). None of them highlighted a vitamin D deficiency as an associated finding of their patient's problem. One publication focused on the metabolic pathology as an underlying cause of stress fractures in the tibia, fibula and femoral shaft (Turturro et al., 2010), but none showed an insufficiency fracture in the femur neck of a child or adolescent.

The study presents the case of a fourteen-year-old female patient with insufficiency fracture at the medial-side of femur neck associated with vitamin D deficiency. To this study knowledge, this is the first report of a looser's zone in the femur neck associated with vitamin D deficiency in an adolescent. The patient and her parents gave consent to the publication of this report.

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## CASE REPORT

A fourteen-year-old female patient was presented to Pediatric Orthopedic Clinic with symptoms of left groin pain and limping since 8 months. The pain started gradually and become progressive with time. The patient denied any recent trauma or participation in any vigorous or sport activity prior to her complaint. She had her menarche at the age of thirteen with regular cycles. She does not get enough sun exposure during the daytime, which is related to cultural reasons, nor get enough vitamin D or calcium-containing dairy products or supply. Her past medical history was remarkable for tonsillectomy and adenoidectomy at the age of 2 years. Her vital signs were normal including a temperature of 37.2°C and a pulse rate of 78. On physical examination, there was painful left hip motion and a negative test for obligatory external rotation when the left hip is passively flexed to 90°. The left leg had normal muscle strength, with no signs of infection. Laboratory investigations, including complete blood cell count and kidney and liver function tests were normal. C-reactive protein level was less than 1 mg/L (normal, less than 5 mg/L), and normal erythrocyte sedimentation rate of 20 mm/h (normal, 0 to 20 mm/h).

Hips and pelvis radiography showed cortical defect surrounded with sclerosis at the medial side of the left femoral neck, but normal femoral head contour noted with no signs of avascular necrosis or slipped capital femoral epiphysis.

However, no nidus was apparently clearly seen on radiography, but osteoid osteoma was included in the differential diagnosis (Figure 1). Accordingly, hips computed tomography (CT) scan (Figure 2) was performed, and revealed cortical disruption at the medial aspect of left femoral neck surrounded with minimal sclerosis, which raised the possibility of insufficiency fracture. Magnetic resonance imaging (MRI) of the hips and pelvis was performed and T1WI showed linear hypointensity (Figure 3), while T2WI including fat saturation showed linear hypo-intensity surrounded with high signal intensity (Figure 4) due to bone marrow and soft tissue edema at the medial side of the left femoral neck. These findings confirmed the diagnosis of insufficiency fracture (looser's zone).

The clinical history did not show any risk factor of overuse or change in the patient life style. Therefore, metabolic work up was carried out to roll out pathological changes that can lead to stress fractures (looser's zone). Accordingly, chemical and endocrine tests were performed and revealed decreased serum calcium level of 7.2 mg/dl (normal 8.5 to 10.5 mg/dl), decreased serum phosphorus level of 2.7 mg/dl (normal 2.7 to 4.5 mg/dl), decreased 25-hydroxyvitamin D (25OHD) level of less than 3.5 ng/ml (sufficiency: 30 to 150 ng/ml), high serum level of parathyroid hormone of 339.9 pg/ml (normal 9 to 55 pg/ml), high serum alkaline phosphatase level of 311



**Figure 1.** Radiography of hips and pelvis showing cortical defect surrounded with minimal sclerosis at the medial side of the left femoral neck (arrow).

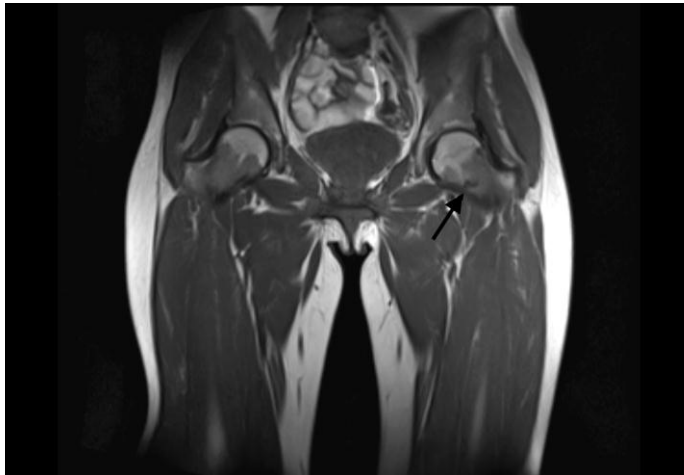


**Figure 2.** Coronal reconstructed CT scan image of the pelvis showing the stress fracture as cortical disruption (arrow) surrounded with minimal sclerosis at the medial aspect of left femoral neck.

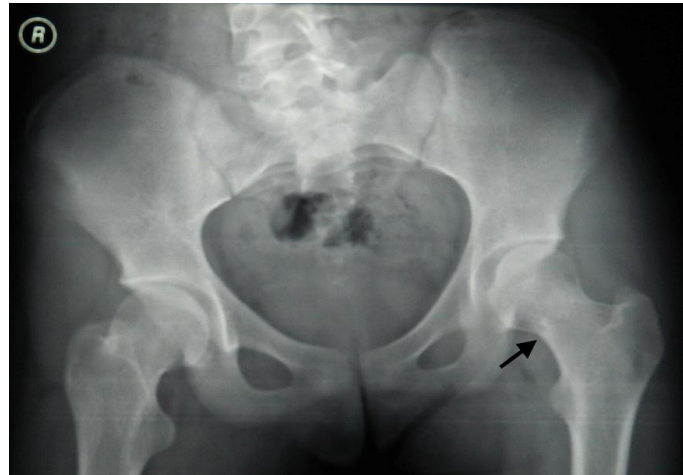
U/L (normal 30 to 120 U/L), normal magnesium serum level of 2.4 mg/dl (normal 1.58 to 2.55 mg/dl), normal thyroid function test, normal follicle-stimulating hormone level, normal 17-beta-estradiol and normal serum cortisol level.

The patient was diagnosed as having vitamin D deficiency with secondary hyperparathyroidism, which might induce femur neck insufficiency fracture and she was started on Vitamin D treatment (50 000 IU once weekly for 8 weeks and then 5000 IU every other day for

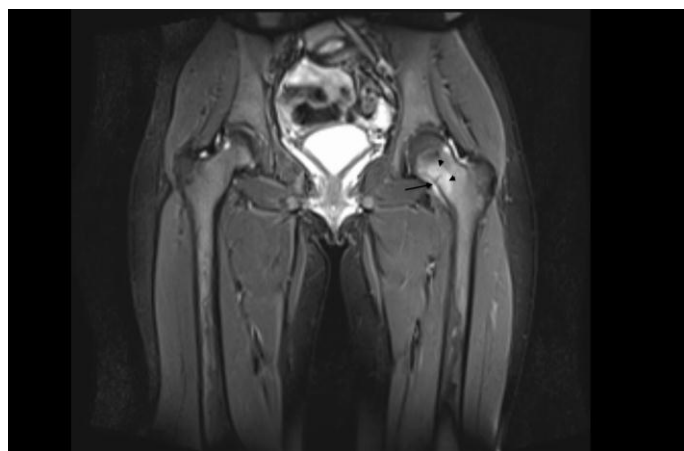




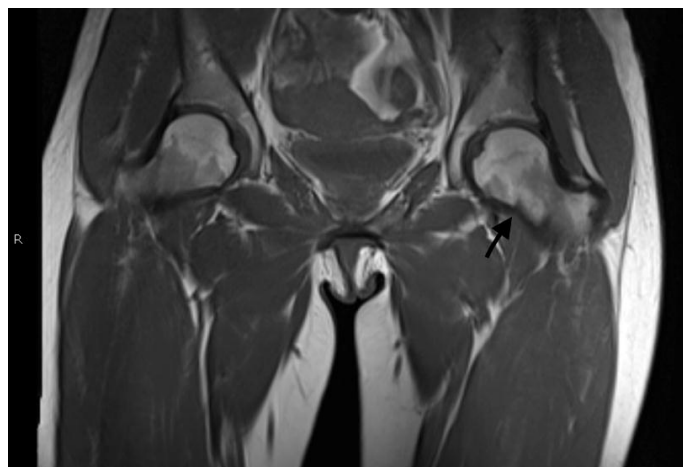
**Figure 3.** Coronal MRI T1W image showing the stress fracture as linear hypo-intensity (arrow) at the medial side of left femoral neck.



**Figure 5.** Radiography of hips and pelvis post Vitamin D treatment showing healed cortical defect (arrow) with no apparent cortical disruption at the medial side of the femoral neck.



**Figure 4.** Coronal MRI T2W image with fat saturation showing the stress fracture as linear hypo-intensity (arrow) surrounded with bone marrow and soft tissue edema seen as signal high intensity (arrow head) at the medial side of the left femoral neck.



**Figure 6.** Coronal MRI T1WI image post Vitamin D treatment showing almost complete resolution the linear hypo-intensity (insufficiency fracture) at the left femoral neck (arrow).

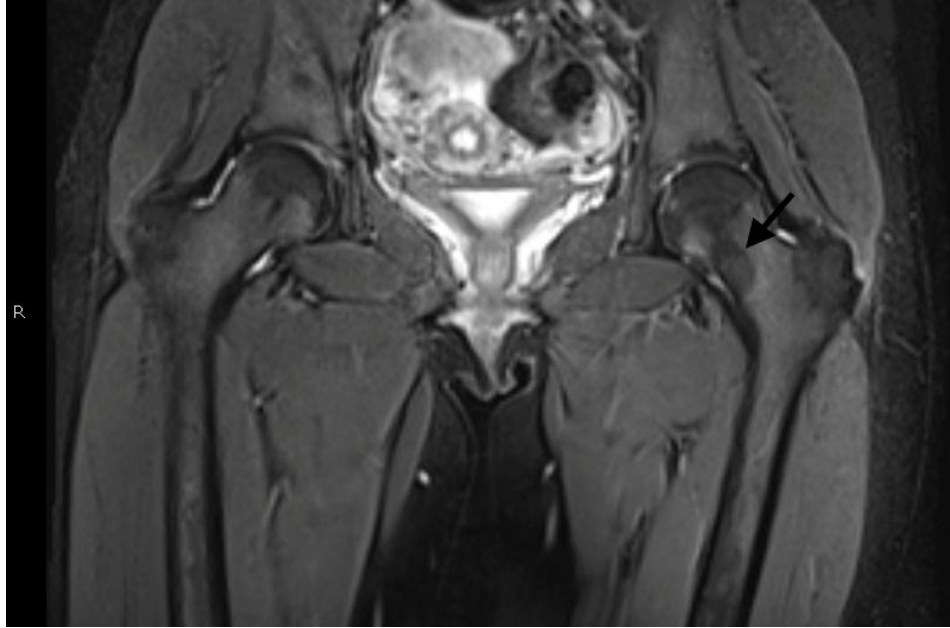
8 weeks) and then she was maintained on 50 000 IU once monthly), and calcium therapy 500 mg PO q8 hours, in addition to non-weight bearing using crutches and pain killer medications. 18 months later the patient walks with full weight bearing without pain, her laboratory investigations showed normalized calcium level of 9.3 mg/dl, normal phosphorus level of 4.1 mg/dl, normal alkaline phosphatase level of 79U/L, improvement of her 25OHD level to 34 ng/ml and parathyroid level has decreased to 128.2 pg/ml.

Hips and pelvis radiography showed healed cortical defect with no apparent cortical disruption at the medial side of the femoral neck (Figure 5). Magnetic resonance imaging (MRI) of the hips and pelvis was performed and

T1WI showed almost complete resolution the linear hypo-intensity (insufficiency fracture) at the left femoral neck (Figure 6), while T2WI (Figure 7) including fat saturation showed absence of the linear hypo-intensity which was seen in Figure 4, with disappearance of the high signal intensity due to bone marrow and soft tissue edema at the medial side of the left femoral neck.

## DISCUSSION

The first femoral neck stress fracture was reported by Devas in an under nourished 14-year-old boy who also



**Figure 7.** Coronal MRI T2WI image with fat saturation showing absence of the linear hypointensity with disappearance of the high signal intensity due to bone marrow and soft tissue edema at the medial side of the left femoral neck. (arrow).

had other stress fractures in the tibia and unilateral avulsion of the ischial tuberosity. He described two types of femoral neck stress fractures (Devas, 1961). First, the transverse type, which is located in the superior tensile part of the femoral neck, and has the tendency of progression, that makes its operative fixation mandatory. The second is the compression type, which is located in the inferior aspect of the femoral neck that has the tendency to heal non-operatively, if the stressful load is relieved (Wolfgang, 1977).

Common disorders that present with hip or groin pain are infection, synovitis, slipped capital femoral epiphysis, leg-calves-perthe's disease, trauma and tumors (Er et al., 2014). In the pubertal stage of development, a common cause of hip pain is a slipped capital femoral epiphysis which was ruled out in our patient due to the normal alignment of the femoral head and neck, and the absent of peri-physeal edematous changes as seen on the MRI of the proximal femur. The other causes were ruled out based on the normality of initial laboratory blood results and the radiological evaluation.

On the basis of absence of typical presentation of femur neck stress fracture with repetitive load, and the absence of signs of healing after 8 months of complaints, the study believed that an underlying endocrinologic or metabolic cause should be present to interpret the present situation. Er et al. (2014) in their literature review and Fiévez et al. (2013) stated that "there were no reports of any underlying medical conditions for a femoral neck stress fracture in children". To the contrary, this study found through the work up which was done for the

study patient a metabolic derangement manifested by a very low level of serum 25OHD (less than 3.5 ng/ml), low serum level of both calcium and phosphorus, high serum alkaline phosphatase level with secondary increase in the parathyroid hormone, representing a well-established case of vitamin D deficiency.

## Conclusion

Femur neck stress fractures are a rare entity in immature children (Kaeding and Miller, 2013). There are less than 20 cases reported in the literature, with female to male ratio of 2.2 to 1, and both sides are affected equally (Table 1). Most of them showed high athletic activities as a risk factor for the fracture development. None of them came through any endocrinologic or metabolic abnormalities that may be associated or precipitate to a femoral neck stress or insufficiency fracture. An accurate diagnosis depends on a systematic approach starting from the clinical history, physical examination and then proper investigations guided by the clues from the patient's clinical evaluation. To the best of this study knowledge, this is the first report of a looser's zone in the femur neck in an adolescent associated with Vitamin D deficiency (Osteomalacia).

## Conflict of Interests

The authors have not declared any conflict of interests.

**Table 1.** Literature review (20 cases) of femur neck insufficiency fracture in a skeletally immature child.

Study	Age (Y)	Sex	Side	Type	Underlying metabolic cause
Wolfgang, 1977	10	F	Right	Compression	No
Miller, 1979	14	F	Left	Compression	No
Coldwell, 1984	11	F	Right	Compression	No
Meaney and Carty, 1992	5	F	Right	Compression	No
	13	M	Right	Compression	No
	9	M	Left	Compression	No
St Pierre et al., 1995	9	F	Right	Compression	No
	7	F	Right	Compression	No
	8	F	Unknown	Compression	No
Scheerlinck and DeBoeck, 1998	8	F	Bilateral	Compression	No
Roman, 2001	8	F	Right	Compression	No
Bettin et al., 2003	12	M	Left	Compression	No
Maezawa et al., 2004	12	M	Left	Compression	No
	5	F	Right	Compression	No
Lehman and Shah, 2004	14	M	Right	Tension	No
Nikolaos et al., 2007	10	F	Left	Tension	No
	5	F	Left	Compression	No
Fiévez et al., 2013	7	M	Left	Compression	No
Er et al., 2014	10	F	Left	Compression	No
	14	F	Left	Compression	Vitamin D deficiency
Present case 2015					Secondary hyperparathyroidism

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