Abstract—Mechanical stimulation mechanism influences bone density by in vitro and in vivo both on human and animal. Stimulation can be done by various methods, such as fluid flow, shear stress, tension, low power ultrasound, and exercise training. It is however, until today the mechanical stimulation in influencing bone density after exercise training up is not clear yet. This research aims to prove the effect of exercise training on increasing FAK expression and its role in influencing bone density. The research design employs “The Randomized Posttest only Control Group Design”. The experimental unit is female rat (Rattus norvegicus), in the age of 2.5 months with six replying and total number are twelve. FAK and bone alkaline phosphatase (BALP) test was measured by using ELISA method. The data was analyzed by using T test and Pearson correlation. The result of this research shows that FAK expression of the exercise training group is higher (3470.12) than control (4197.00) a 0.01. Based on Pearson correlation analysis shows that increasing of FAK has positive correlation with bone marker BALP. The conclusion of this research is exercise training can increase FAK expression and has positive correlation with BALP.

Key words: Exercise training, FAK expression, bone density, osteoporotic risk.

I. INTRODUCTION

Up to now, the mechanical stimulation mechanism in inflicting signal upon the osteoblast activity in bone is not clear yet. One of hypotheses is through the phenomenon which is known as mechanotransduction. Mechanotransduction comprises of the changing of biophysical activity into cellular and molecular activity (biochemical). The mechanotransduction in bone covering 4 phases, these are: mechanocoupling, biochemical coupling, transmission signal from censor cell to the effectors cell and effectors cell’s response. The whole mechanism is responsible to the dynamic of balance between bone forming and bone resorption (remodeling) [1]. Furthermore, [2] the mechanical stimulation can influence transcription factor, as well as influence the gene expression which responsible upon the development and sustainment of the tissue. In vitro shows that mechanical stimulation increase osteoblast proliferation in bone cell progenitor bone marrow mesenchymal stem cell (MSCs)); however the mechanism of increasing proliferation and differentiation osteoblast has not clear yet.

Focal adhesion complex (FAC) engages the integrin and binds with the ECM (extra cellular matrix) takes part in responding signal from the outside cell into the cell, in order to create response from the cell. Focal adhesion that takes part in transduction signal is named focal adhesion kinase (FAK). FAK is a protein tyrosine kinase in which engaged with β integrin in integrin receptor in all types of cell. Additionally, the binding between integrin and ECM will activate the FAK and will take part as mediator signaling in which organized the development, morphogenesis, and defense [3].

Furthermore, the mechanical stretch model influences the FAK signaling through the advancing of FAK phosphorylation and further it can influence tenogenic differentiation[3-4]. The similar model of mechanical stimulation is given to the culture rat mesenchymal stem cell (rMSC). The research [5] shows that FAK-ERK signaling is necessarily needed for proliferating in progenitor osteoblasts cell. ERK (extra cellular signal regulated kinase) is a protein kinase from mitogen activated protein kinase (MAPK), ERK takes part in controlling cell in proliferation, differentiation [6], in the case of osteoblast cell, ERK influence c-bfa (core binding factor) gene, proliferation and cell adhesion [7]. Nevertheless, the way of transduction signaling integrin-ERK to the gene expression after exercise training is not clear yet.

II. MATERIAL AND METHODS

A. Material and Methods

This research is an experimental research. It employed The Randomized Posttest only Control Group Design Gibbon et al (1997). The experimental unit in this research was white rat strain Wistar, female in the age of 2.5 months. The independent variable was exercise training on moderate intensity, and the dependent variables were FAK expression and bone density that is through Bone Alkaline Phosfatase (BALP).

The treatment was exercise training in moderate intensity for 45 minutes (independent variable). The dependent variable is 1 expression FAK and bone density through Bone Alkaline Phosfatase (BALP). This research was conducted at Laboratory of Physiology University of Gadjah Mada for exercise training and the examination on FAK and BALP was conducted in the Laboratory of Physiology Sciences, Brawijaya University in Malang.
B. Research procedure

Firstly, it conserves the sample from age 2.5 months till 3 months. Second, acclimatization the control group and experimental group for 2 weeks in order to adapt to the research environment. For the experimental group, the rats were introduced to the treadmill by running on a treadmill. This was an intended procedure, so that when the study was conducted the sample had adapted to the treadmill. The exercise training was conducted in moderate intensity treatment. Each treadmill took place for 5 times in a week. The exercise training was done in 45 minutes and took a rest for 5 minutes in the middle of the treatment after 25 minutes running.

After the sample had 2 months of treatment, the sample put into sleep in order to take their upper leg part (femur). The upper leg part from the muscle tissue which attached to the bone was cleaned and disposed. After taking the bone density measurement, only the bone part remained. The protein isolation and SDS-PAGE performed after the bones were cleaned. Then, examine the expression of FAK and BALP employed ELISA Method.

III. RESULT AND DISCUSSION

The Data obtained from the examination of the expression of FAK and BALP employed ELISA Method. The data expression of FAK and BALP are presented in Tables 1 and 2.

**TABLE 1. THE AVERAGE OF FOKAL ADESION KINASE EXPRESSION IN POSTTEST EXERCISE TRAINING**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>Exercise training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average µ/ml</td>
<td>726.550</td>
<td>853.760</td>
</tr>
</tbody>
</table>

**TABLE 2. THE AVERAGE OF BONE ALKALIN PHOSFATASE EXPRESSION IN POSTTEST PHYSICAL TRAINING**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>Exercise training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average µ/ml</td>
<td>3470.12</td>
<td>4197</td>
</tr>
</tbody>
</table>

The average number in Table 1 and Table 2 contribute the data expression of FAK and BALP in exercise training. They were higher than the control group. In α 0.01. The Pearson correlation test showed that a positive correlation between the increasing expression FAK and BALP as the marker of bone density.
IV Conclusion
The conclusion of this research is the increase of exercise training can increase the FAK expression. It has positives correlation with BALP.

V Acknowledgement
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References