

# BONE PROPERTIES AND BLOOD BONE METABOLISM MARKERS IN RESPONSE TO EXERCISES AND HONEY SUPPLEMENTATION: A CONTEMPORARY REVIEW

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## ABSTRACT

Osteoporosis is a disease characterised by a loss of bone mass and the structure deterioration of bone tissue, resulting in bone fragility and fractures. This disease imposes major burden on the health economy and being recognised as one of the major public health problems worldwide. To date, many strategies have been developed with the aim of preventing bone loss and increasing bone mass, these include involvement in physical activity programmes and through appropriate nutritional intake. Honey contains mainly carbohydrates, vitamins and minerals such as calcium, phosphorus and magnesium, which are believed to be important for enhancing bone health. This article discusses the findings of several research studies on bone properties and blood bone metabolism markers in response to combined exercises and honey supplementation in animals and humans, which have been carried out by the bone and exercise research team of Universiti Sains Malaysia.

**Keywords:** *Osteoporosis, exercise, honey supplementation, blood bone metabolism*

## INTRODUCTION

The recognition of osteoporosis as a major health problem among the growing number of elderly people around the world has resulted in widespread efforts to determine the etiology of the disease and how it might be delayed or prevented. One strategy is to increase bone mass during the formative years of life and then subsequently either try to maintain the gain or reduce the rate of bone loss. These could be achieved through adequate nutritional intake and regular weight bearing exercises.

Weight-bearing exercises such as walking, running, dancing, and jumping are particularly necessary to help develop and maintain strong bones. Besides regular weight-bearing exercises, nutrition also plays an important role in enhancing and maintaining bone health. Honey contains carbohydrates such as glucose, fructose, sucrose and raffinose. Honey also contains enzymes, flavonoids, antioxidants, minerals, organic acids, proteins, phenolic acids, and vitamins such as

vitamin C and vitamin E (Aljadi *et al.*, 2004). Some of these components are believed to be important for enhancing bone health. It was reported previously that taking honey appeared to enhance calcium absorption in rats and could therefore play a role in boosting bone health (Ariefdjohan *et al.*, 2008). Additionally, in another study, it was found that in a group of young Sprague Dawley rats fed with honey for 52 weeks, their bone mineral density was significantly greater than the sugar free diet-fed controls (Chepulis & Starkey, 2008), this again indicates that honey may enhance bone health in animals.

Since the combined effect of honey and exercise in animal has not been confirmed, thus the present research team has conducted a study to investigate the effect of this combination on bone in rats. We found that there were beneficial bone effects elicited by combined jumping exercise and honey supplementation with increased bone mineral density, geometry, mechanical properties, and bone metabolism in female rats (Tavafzadeh *et al.*, 2011; Ooi *et al.*, 2014) (Figure 1).

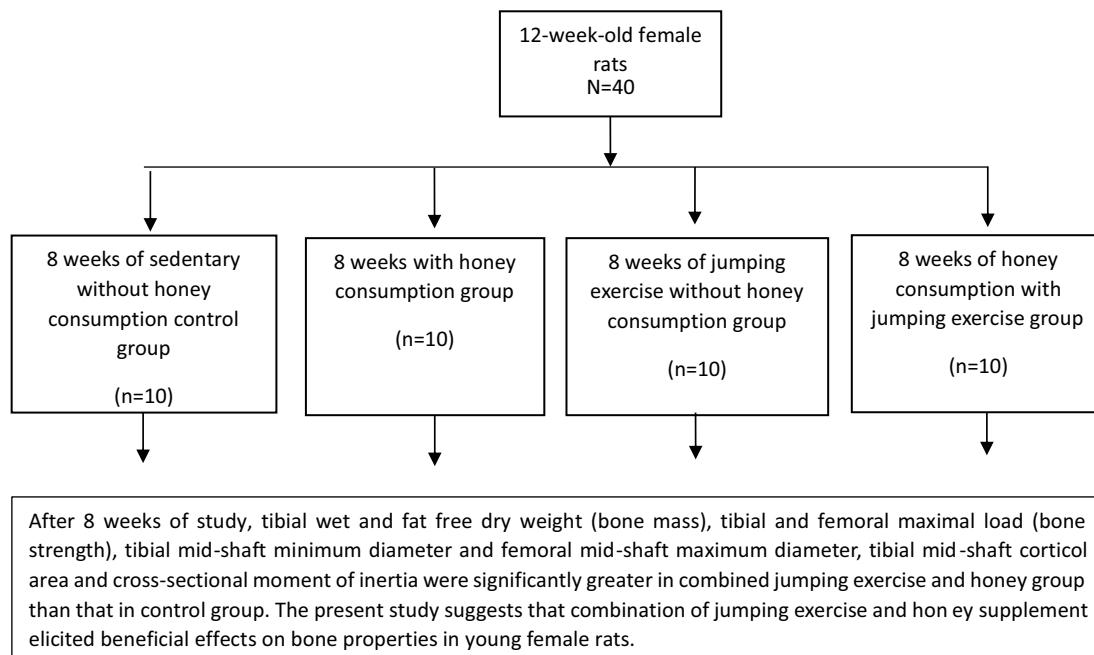
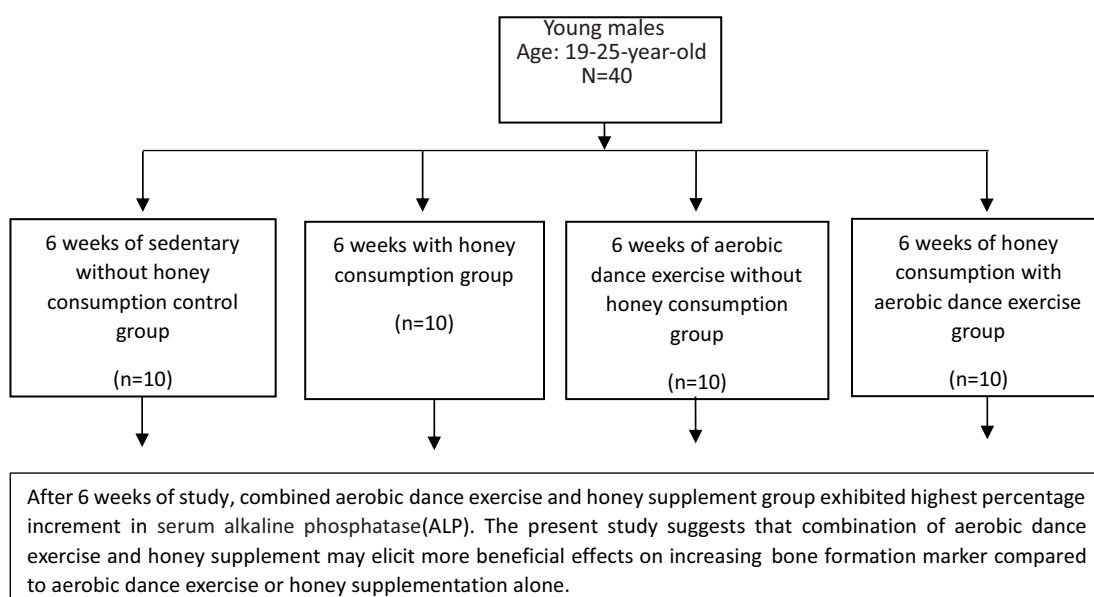


Figure 1: Graphical summary of the study on effects of combined jumping exercise and honey supplementation on bone mass, strength, physical dimensions, geometry and mechanical properties in rats (Ref: Tavafzadeh et al., 2011; Ooi et al., 2014)

As an extension work of the animal study mentioned above, the present research team has carried out a study for determining the effect of 6 weeks of combined aerobic dance exercise and honey supplementation on bone metabolism markers in young females (Ooi et al., 2011). The measurable changes in bone mineral density by

using bone densitometry such as Dual Energy X-ray Absorptionmetry scanning are expected not to be observed in a short duration of 6 weeks, therefore this study focused on changes in blood parameters, where changes in blood bone turnover markers such as serum (1CTP) as bone resorption marker were observed (Figure 2).

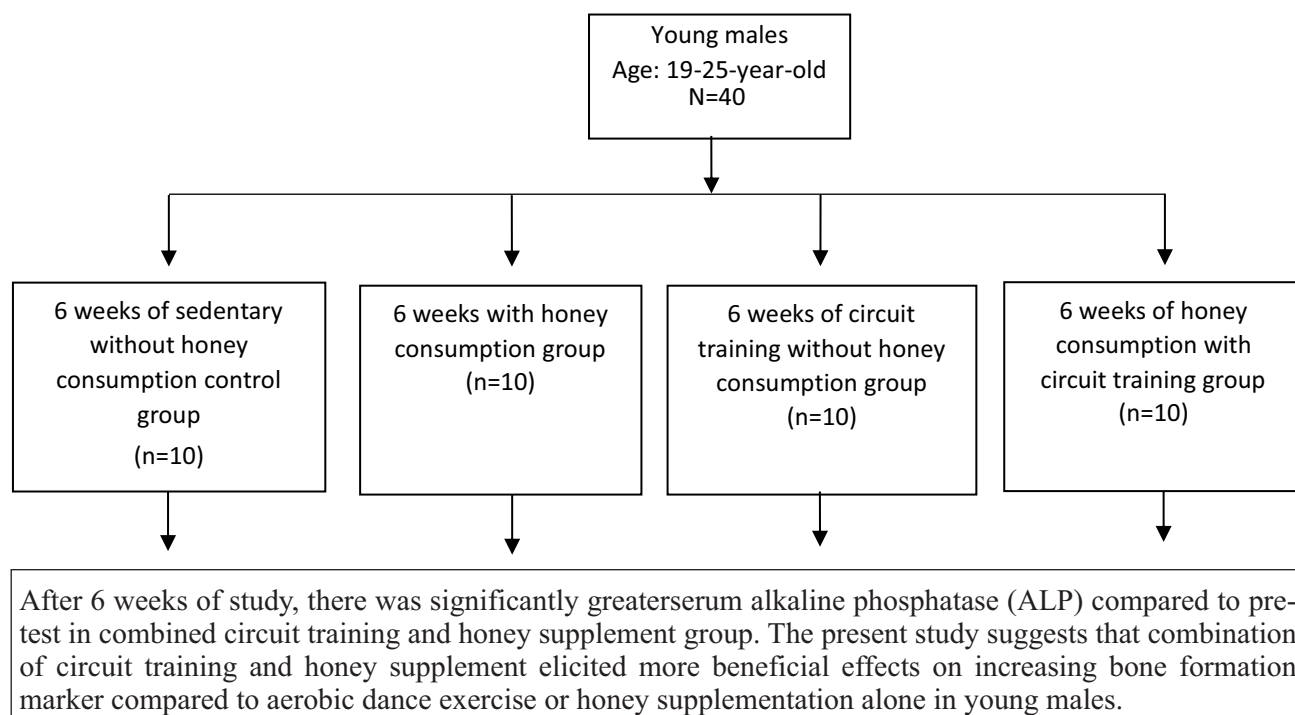


**Figure 2: Graphical summary of the study on effects of combined aerobic dance exercise and honey supplementation on bone turnover markers in young females (Ref: Ooi et al., 2011)**

In this previous human study involving young females, it was found that six weeks of aerobic dance exercise at three times per week, one hour per session combined with daily consumption of 20g of honey diluted in 300 ml of plain water elicited more beneficial effects on bone health by increasing blood bone formation marker in 19 to 29 years old young females compared to honey supplementation alone or exercise alone (Figure 2).

In addition, the present research team also conducted a study with circuit training and honey supplementation in young males with age 19 to 25 years old. The circuit

training consisted of 2 circuits with 10 different activities, i.e. hand elastic bend exercise, leg elastic bend elastic, free-weight dumbbell triceps extension, rope skipping, free-weight dumbbell concentration curl, sit-up, back extension, burpee, push-up and split squat. Circuit training was performed at three times per week for six weeks. It was found that six weeks of combined circuit training and daily honey consumption of 20g of honey diluted in 300 ml of plain water elicited beneficial effects on increasing blood bone formation marker in young males (Ooi & Aziz, 2017) (Figure 3).



**Figure 3: Graphical summary of the study on bone metabolism markers in response to circuit training and honey supplementation in young males (Ref: Ooi & Aziz, 2017)**

It was speculated that bone response varies with age, thus bone metabolism may be different in older population compared to young females with the combination of exercise and honey supplementation. Therefore, an extension work of the above mentioned

study was carried out for determining the effectiveness of combination of aerobic dance exercise and honey supplementation on bone metabolism markers in adult women with age ranging from 25 to 40 years old (Rahim et al., 2016) (Figure 4).

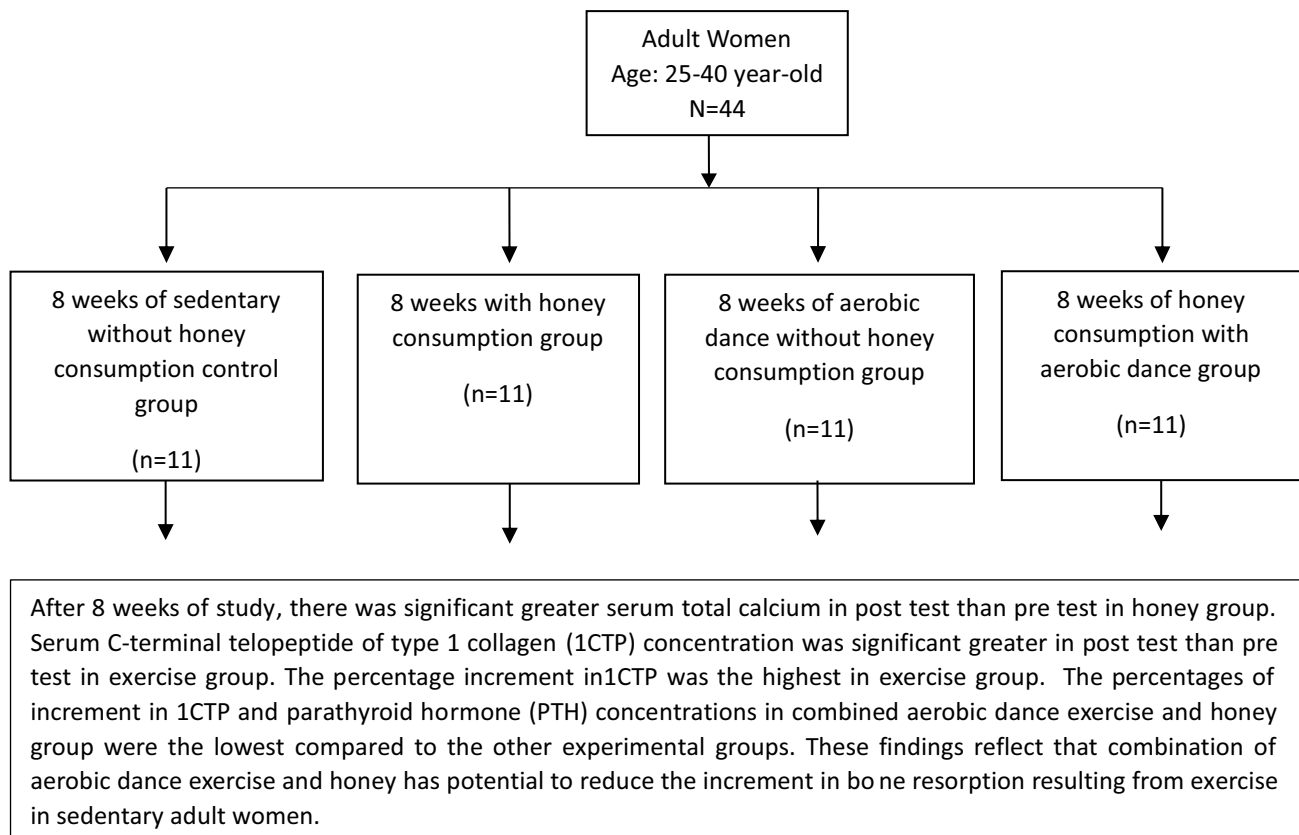


Figure 4: Graphical summary of the study on changes of bone metabolism markers and muscular performance with combined aerobic dance exercise and honey supplementation in adult women (Ref: Rahim et al., 2016)

This previous study which involved adult females found that honey supplementation alone could significantly elevate serum total calcium level, whereas aerobic dance sessions alone could significantly elevate bone resorption. It was also found that combination of aerobic dance exercise and honey supplementation may elicit beneficial effects on reducing bone resorption induced by exercise in sedentary adult women (Figure 4).

It is well known that mechanical loading has an effective role in increasing bone health, in which an adequate exercise program can promote bone development and protect bone against age-related bone loss (Berard et al., 1997). Evidences show that osteogenic effects of mechanical loading are dependent on the type, magnitude and rate of the applied load (Maimoun et al., 2006). Dynamic and high magnitude loading such as jumping exercise which elicits great ground reaction force could elicit beneficial effects on

bone health (Umemura et al., 1997; Ooi et al., 2009; Tavafzadeh et al, 2011). Nevertheless, it is believed that strenuous exercise may not be beneficial for enhancing bone health status. (Matsuda et al., 1986; Hou et al., 1990; Li et al., 1991; Maynard et al., 1995).

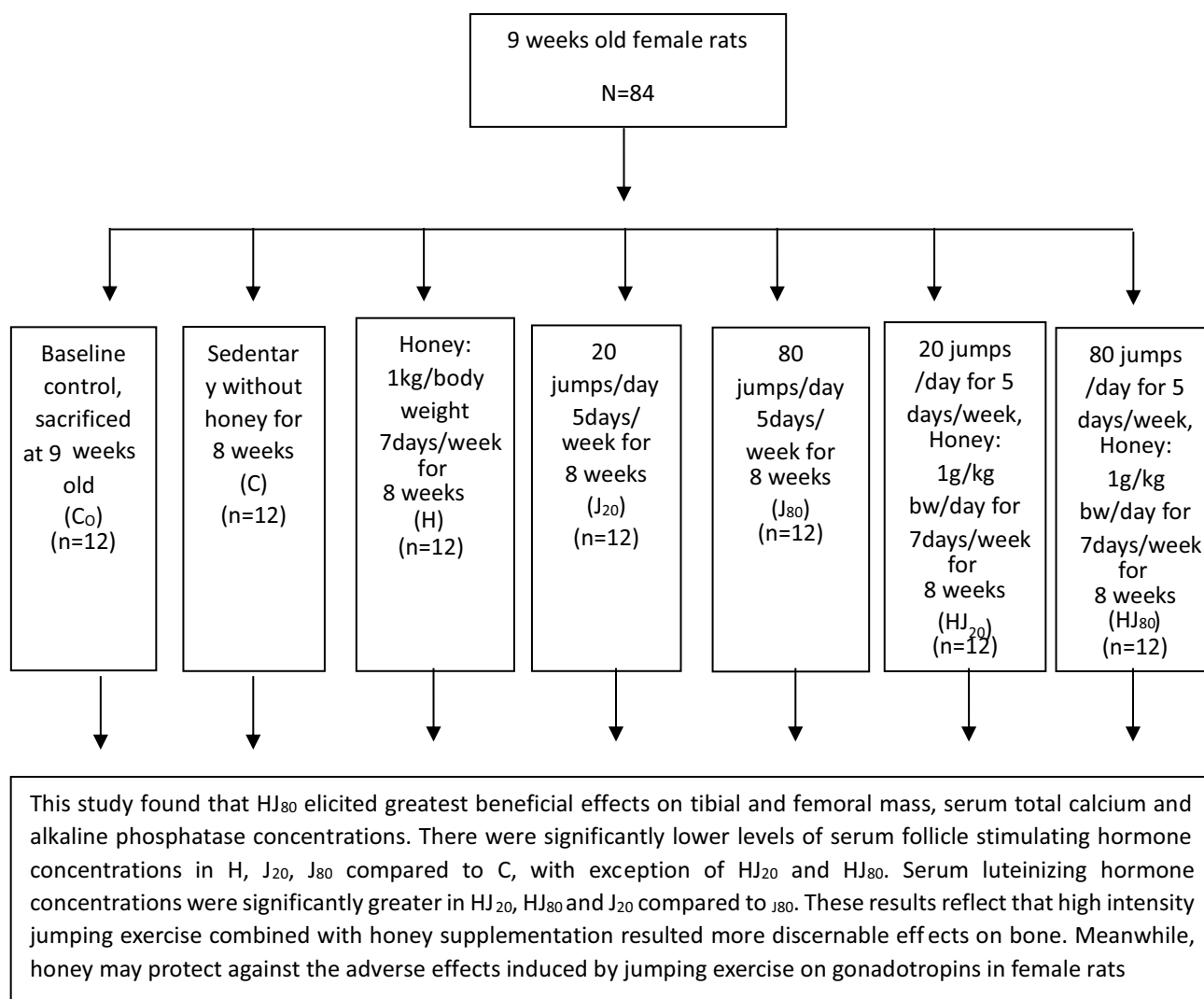
It was mentioned by Mastorakos et al.,(2005) that strenuous exercise is related with a decreased hypothalamic-pituitary-adrenal secretion. The stress of exercise can affect the gonadal function negatively. High training intensity activates the hypothalamus pituitary adrenal axis to increase secretion of androgens, in particular dehydroepiandrosterone sulfate (DHEA-S), and cortisol which disrupts gonadotropin releasing hormone (GnRH) pulsatility, resulting in menstrual abnormality among female athletes involved in strenuous exercise. Additionally, it was mentioned by Warren & Perlroth (2001) that low caloric input and high caloric expenditure can result in endocrine abnormalities, and this could be a factor

which affects gonadotropin-releasing hormone suppression that manifests as menstrual disturbances with strenuous training. The consequence effects of strenuous exercise on female menstrual dysfunction consist of amenorrhea, infertility and osteoporosis.

## DISCUSSION

To date, information is lacking on the effects of combined higher intensity of jumping exercise with honey on bone health and gonadotropins compared to combination of lower intensity of jumping exercise with honey in female rats. Moreover, we hypothesize

that honey as a source of energy and its antioxidant properties may protect against adverse effects induced by exercise on gonadotropin hormones. Therefore, the present research team has carried out a study to investigate the effects of different jumping exercise intensities, i.e. low and high intensities combined with honey supplementation on bone parameters and gonadotropins in female rats (Mosavat *et al.*, 2014). This study found that high intensity jumping exercise combined with honey supplementation resulted in more discernable effects on bone mass and blood bone metabolism markers. Meanwhile, honey may protect against the adverse effects induced by jumping exercise on gonadotropins in female rats (Figure 5).



**Figure 5:** Graphical summary of the study on effects of honey supplementation combined with different jumping exercise intensities on bone mass, serum bone metabolism markers and gonadotropins in female rats (Mosavat *et al.*, 2014).

## CONCLUSION

In summary, our human studies showed that supplementation of honey drink with 20g of honey diluted in 300ml of plain water combined with 3 days per week of aerobic dance exercise has potential to be proposed for formulating guidelines in planning exercise and nutrition promotion programmes to elicit beneficial effects on bone metabolism compared to exercise or honey supplementation alone in female population with different age, i.e. both young and adult females. Meanwhile, our animal study showed that high intensity jumping exercise combined with honey elicited great beneficial effects on bone mass and bone metabolism markers. In addition, honey could elicit protective effects on disturbance of reproductive hormone levels induced by high and low intensities of jumping exercise. Therefore, honey may be able to be recommended to female athletes for maintaining their bone health and normal reproductive functions.

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