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Original Article

Combined Effect of Honey Supplementation and Walking Exercise on Antioxidant Enzyme Markers in 50 to 65 Years Old Postmenopausal Women

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Abstract

Background: This study examined how honey supplements and walking exercise affected antioxidant enzymes in postmenopausal women between the ages of 50 and 65 years old. **Methods:** Forty participants were split into four groups: walking exercise alone (Ex), honey supplementation alone (H), sedentary without honey supplementation control (C), and combination honey supplementation and walking exercise (HEx) groups. The H group consumed 20g of honey daily for six weeks, while the Ex group performed walking exercises 30 min per day, thrice a week for six weeks. The HEx group followed both regimens. Anthropometry, body composition, levels of glutathione peroxidase (GPx) and superoxide dismutase (SOD) in the blood were measured. Statistical analysis was performed by using repeated measure analysis of variance (ANOVA). **Results:** There are significant increases in body weight in C, H and Ex groups but no significant changes in body fat percentage in all the groups. SOD levels remained unchanged in all the groups However, the Ex-group's GPx was significantly greater (p=0.016) at the post-test than it was at the pre-test. Additionally, a propensity for a significant rise (p=0.05) in GPx relative to its pre-test value was observed in the HEx group. **Conclusion:** The results suggest that giving postmenopausal women aged 50 to 65 honey supplements for six weeks had no discernible effect on their GPx activity. However, walking exercise and their combination with honey supplementation have the potential to increase GPx activity. Nevertheless, more studies with longer study duration are warranted to confirm their efficacy.

Keywords: *Antioxidant Enzymes; Honey Supplementation; Postmenopausal Women; Walking Exercise*

Introduction

Antioxidants are molecules that protect against the harm caused by free radicals. Free radicals' harmful effects are offset by antioxidants, which include enzymes and other compounds including beta-carotene, vitamin C, and vitamin E by preventing cellular damage from chemical reactions. A substantial body of

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evidence has emerged in recent years that suggests oxidative stress has been linked to the pathophysiology of common diseases like diabetes mellitus, atherosclerosis, and chronic renal failure. It also demonstrated that free radicals play a significant role in many basic cellular reactions (Valko *et al*., 2006). When pro-oxidant and antioxidant status are out of proportion in favour of the former, oxidative stress will occur (Sen, 1995). In such states, free radicals are dangerous to our bodies because they can potentially break or damage other important molecules (Tortora & Derrickson, 2009).

In recent decades, antioxidants have gained attention as a nutritional approach to prevent or minimise the harmful effects of reactive oxygen and nitrogen species (RONS) produced both during and following intense exercise (Powers & Jackson, 2008). Athletes commonly use antioxidant supplementation to lessen oxidative stress, promote recuperation from injuries, and improve sports performance (Peternelj & Coombes, 2011). Higher antioxidant dosages, however, may have negative consequences by interfering with systems that improve performance (Gomez-Cabrera, Domenech & Viña, 2008).

Supplementation with antioxidants may not only enhance well-being of menopausal women facing elevated oxidative stress whether stemming from menopause itself or from other lifestyle choices like smoking, stress, drinking too much alcohol, and unhealthy dietary habits. Research indicates that the vitamins E (alpha-tocopherol) and C (ascorbic acid) are beneficial antioxidants for women during the perimenopausal and postmenopausal stages (Doshi & Agarwal, 2013). These vitamins play a crucial role in scavenging free radicals and ameliorating oxidative stress. A study examining the impact of these vitamins on postmenopausal women revealed that those who did not include vitamins C and E in their diets exhibited elevated levels of the oxidative stress marker malondialdehyde, along with reduced activity of the antioxidant enzymes superoxide dismutase and catalase (Doshi & Agarwal, 2013; Fisher et al., 2025).

Honey is one of the natural ingredients that possess antioxidant properties. Honey bees make honey, a naturally occurring sweet liquid made from floral nectar. A range of substancers are present in it, such as proteins, enzymes, minerals, carbohydrates, vitamins, amino acids, and phenolic compounds.

Because of environmental conditions, season, floral origin, and beekeeper care, different types of honey have distinct contents (Alvarez-Suarez *et al*., 2010). Tualang honey, a local Malaysian honey got its name from the Tualang tree where the bees made their nests. Tualang is Asia's largest tree (up to 80 m), and located in the lowland rainforests of Borneo, Palawan, southern Thailand, Peninsular Malaysia, and northeastern Sumatra (Husniati *et al*., 2013). Numerous bioactive substances, including phenolic acids, flavonoids, vitamins, and enzymes, are present in Tualang honey. The biological makeup of honey and its overall antioxidant potential are significantly influenced by the geographical and botanical regions as well as the type of bees that produced it (Erejuwa, Sulaiman & Ab Wahab, 2012).

Strenuous physical exercise may overwhelm antioxidant defences, especially in skeletal muscle and the heart, making them susceptible to oxidative stress (Sen, 1995). The human body is protected from free radicals by natural antioxidant enzymes, including glutathione peroxidase (GPx), superoxide dismutase (SOD) and catalase. In order to convert superoxide radicals into oxygen, SOD is mostly found in mitochondria and the cytoplasm of cells. GPx catalyzes the oxidation of glutathione (GSH) into glutathione disulphide (GSSG). GPx, which is present in mitochondria, the cytosol and cell membranes, uses reduced glutathione (GSH) as an electron donor to reduce H_2O_2 and organic hydroperoxides (Deaton & Marlin, 2003).

Consistent physical activity, in association with dietary habits that provide a sufficient intake of suitable antioxidants is expected to yield desirable health benefits (Sen, 1995). Exercise has also been shown to increase antioxidant status. For example, Cebula *et al*. (2017) reported enhanced blood antioxidant defence systems following six weeks of Nordic walking in sedentary women. In addition, frequent exercise reduces the negative effects of free radicals and has many health benefits, including a decreased risk of chronic disease, skeletal muscle sarcopenia, all-cause mortality, and early death in older adults (Simioni *et al*., 2018). Exercise recommendations for women in the perimenopause or post menopause are essentially similar to those for all women, under the American College of Sports Medicine's (ACSM) 2010 guideline for exercise testing and prescription. The main goal of the walking

exercise is to help improve health and reduce symptoms caused by this population's natural changes in the body.

To date, data on the impact of walking exercise and Tualang honey supplementation on antioxidant enzymes among postmenopausal women are scarce. Thus, this study was proposed to examine the possible advantages of ingesting Tualang honey and regular walking exercise on superoxide dismutase (SOD) and glutathione peroxidase (GPx) in Malaysian women aged 50 to 65 who are postmenopausal. The rationale for this study arises from the need to explore natural intervention that can enhance wellbeing and health of postmenopausal women, who are particularly vulnerable to oxidative stress and its associated health risks.

Methodology

Participants

This study is an interventional, randomised, controlled trial study using an opportunistic sampling method. Forty postmenopausal women aged between 50 and 65 years were recruited in this research. Participants were chosen based on the specific inclusion criteria: they must have been naturally postmenopausal for more than a year, be in stable health without chronic diseases such as cancer, diabetes, cardiovascular disease and not smoking. Additionally, they should not have been engaged in regular exercise programs or consumed honey. Once qualified, participants were then assigned at random and matched by age into the following four groups: sedentary without honey consumption control group (C), honey consumption alone group (H), walking exercise alone group (Ex) and combined walking exercise with honey consumption group (HEx). Each participant received detailed information about the objectives, methods, advantages, risks, and possible discomforts of this research. They were free to withdraw at any time during the six-week experimental period.

G Power Software was utilised to determine the sample size for this investigation. The study's power was set at 80% with a 95% confidence interval and 30% of effect size. Each group targeted nine participants, accounting for an anticipated 10% dropout rate, leading to the recruitment of ten participants per group. Consequently, the study enrolled a total of 40 participants across the four groups.

Participants' Grouping

The participants in this study were divided into four groups, each consisting of ten people, i.e. sedentary without honey consumption control group (C), honey consumption alone group (H), walking exercise alone group (Ex) and combined walking exercise with honey consumption group (HEx). For six weeks, members of the control group (C) did not engage in any walking activities or consume honey. Participants in the honey consumption alone (H) group drank 20 g of honey dissolved in 300 ml of plain water daily for 6 weeks. Participants in the walking exercise alone group (Ex) performed walking exercise 30 min per session, three sessions per week for 6 weeks, while individuals in the combined honey consumption and walking exercise group (HEx) ingested 20 g of honey diluted in 300 ml of plain water daily for a total of 6 weeks, and conducted walking exercise 30 min per session, three times a week for the same duration (Pescatello, Thompson & Gordon, 2009)

Blood Sampling, Anthropometric and Physiological Characteristics Measurements

Blood samples were collected from participants at two-time points: immediately before and after the six-week experimental period in the morning (8.30 a.m.). Following an 8-hour overnight fast, 2 ml of resting venous blood were drawn from each participant's antecubital vein. Participants were permitted to drink plain water during this fasting period.

For participants in the Ex and HEx groups, blood samples at post-exercise were drawn 14 to 16 hours after completing their evening exercise sessions, typically between 8:30 a.m. and 10:30 a.m. the next morning. Laboratory technologists at the Exercise and Sport Science Laboratory, School of Health Sciences, Universiti Sains Malaysia, conducted the blood sampling (Gomez-Cabrera *et al.*, 2005).

Both before and after the experimental trial, anthropometric and physiological characteristics were measured, including body height, weight, and body composition, or the proportion of body fat. A Stadiometer (Seca 220, Germany) was used to measure body height. A Tanita model TBF-410 body composition analyser was used to measure both body weight and body composition. Participants were required to be shoeless and wear minimal clothes during these measurements. For measuring blood pressure, an electronic sphygmomanometer was used.

Walking Exercise Programme

Attendance for the prescribed walking exercise programme (30 min per session, 3 times per week for 6 weeks) was mandatory for participants in the walking exercise alone (Ex) and combined honey supplemented and walking exercise (HEx) groups. In each walking exercise session, the participants warm up with stretching activities for five minutes, and then started walking for 30 minutes, followed by cooling down by doing stretching activities for five minutes. The program was conducted under the supervision of the researcher at Sport Complex 2 in Universiti Sains Malaysia's Health Campus.

Prior to the exercise sessions, participants determined their estimated maximal heart rate (HRmax = 220 bpm – age) and the targeted exercise heart rate range. Following the walking sessions, they monitored their post-exercise heart rate to make sure the training intensity was maintained within the desired range. The walking exercise intensity should be within the range of 50%-65% of the participants' estimated heart rate maximum (HRmax), i.e. moderate exercise intensity. The participants were required to alter their pace during the next walking session if the walking pace did not cause their heart rates to reach within the previously stated range of exercise heart rates. The participants wore wear heart rate monitors to get an accurate heart rate reading of their post exercise heart rate (Wadiah *et al*., 2015).

Honey Consumption

Participants in the honey (H) and the combined walking exercise and honey supplementation (HEx) groups in this study ingested a honey drink daily for six weeks. The drink consisted of 20 g of Tualang honey (provided by the Federal Agriculture Marketing Authority, Malaysia), mixed with 300 ml of plain water. Participants in the HEx group were instructed to ingest the honey drink 1 h prior to each walking exercise session on exercise days. To ensure compliance and track their progress, participants recorded their daily honey consumption and exercise frequencies on provided checklists.

Blood Biochemical Analysis

The serum was analysed for antioxidant enzymes which were serum glutathione peroxidase (GPx) and superoxide dismutase (SOD). Four ml of blood was taken during pre-and post tests to determine the levels of these two enzymes.

Statistical Analysis

Version 22.0 of the Statistical Package for Social Sciences (SPSS) was used to analyse all of the data. The means and standard deviation (S.D.) are used to report the results. A two-way analysis of variance (ANOVA) using repeated measures was used to determine how significant the differences were both within and between the groups. A p-value of less than 0.05 was considered statistically significant.

Ethical Consideration

The research obtained ethical clearance from thethe Human Research Ethics Committee of Universiti Sains, Malaysia with reference number: USM/JEPeM/18020139 on 20th May 2018.

Results

Demographic Data

In the context of research articles, demographic data serves to provide a general overview of the characteristics of the participants who are the subjects of the study. In this study, the data collected to describe the sociodemographic characteristics of the respondents included the year of graduation,

length of employment, and training in Good Compounding Practice (GCP). The results of the respondent's characteristics in this study are presented as follows:

Table 1: Percentage of Respondents Based on Year of Graduation

Year of Graduation of Pharmacists	Number of Respondents (Persons)	Percentage (%)
1998-2002	1	2
2003-2007	1	2
2008-2012	1	2

Anthropometric and Physiological Characteristics of the Participants

37 participants of this study had a mean age of 56.8±2.9 years. Three participants, each from the control (C) group, exercise group (Ex) and combined group (HEx) respectively did not complete the study because of private concerns. Table 1 illustrates the baseline mean age, body weight, body height, body mass index (BMI), percentage of body fat, systolic blood pressure and diastolic blood pressure of all the participants, according to their respective groups. The four groups' mean body height, body mass index (BMI), percentage of body fat, systolic blood pressure, and diastolic blood pressure did not differ significantly at the pre-test. Table 2 shows the mean body weight and percentage body fat at pre- and post tests of all the groups.

The repeated measures ANOVA revealed no significant interaction between time and intervention on body weight (df=3, F=0.199, p=0.897). However, significant main effects were found for both time (df=1, F=21.003, p<0.001) and intervention (df=3, F=3.688, p=0.021) on body weight. Further analysis showed that the participant's body weight increased dramatically after six weeks of the trial period at post test in C (p=0.016), H (p=0.031) and Ex (p=0.011) groups compared to pre test. HEx group exhibited significantly lower body weight compared to the H group at both pre-test (p=0.023) and post-test (p=0.018) (Table 3).

There was no discernible relationship between time and intervention in terms of body fat percentage (df=3, F=2.106, p=0.118). Additionally, neither time (df=1, F=0.167, p=0.685) nor intervention (df=3, F=0.971, p=0.418) showed any significant main effects on the percentage of body fat.

Table 2: The Participants' Baseline Anthropometric and Physiological Traits

Parameters	All Participants (N=37)	C Group (n=9)	H Group (n=10)	Ex Group (n=9)	HEx Group (n=9)
Age (years)	56.8±2.9	56.3±2.9	57.6±3.7	56.7±3.0	56.6±1.9
Body weight (kg)	65.0±9.7	67.2±8.7	70.9±6.7	63.0±12.2	58.3±6.8
Body height (cm)	154.2±4.8	152.0±5.1	156.0±5.2	154.3±3.6	154.4±4.9
Body mass index (BMI) ($kg.m^{-2}$)	27.5±4.2	29.2±3.4	29.3±3.1	26.6±5.3	24.7±3.6
Percentage of body fat (%)	39.2±7.2	41.7±8.2	41.0±6.7	38.3±6.1	35.7±7.2
Systolic blood pressure (mmHg)	133.2±13.9	139.0±13.6	128.8±13.4	138.0±15.6	127.7±11.1
Diastolic blood pressure (mmHg)	78.3±8.8	79.0±6.9	80.0±7.8	78.4±8.9	75.6±11.8

Values are expressed as mean±SD

Table 3: Body Fat Percentage and Mean Body Weight of the Participants at Pre and Post Tests

Body Weight (kg) (Mean±SD)			
Groups	**Pre test**	**Post test**	**Percentage change**
C	67.2±8.7	68.2±8.0*	+1.53
H	70.9±6.7	71.7±6.6*	+1.16
Ex	63.0±12.2	64.0±12.3*	+1.62
HEx	58.3±6.8#	59.0±6.8#	+1.09
Percentage of Body Fat (Mean±SD)			
Groups	**Pre test**	**Post test**	**Percentage change**
C	41.7±8.2	41.5±6.2	+0.16
H	41.0±6.7	42.0±5.2	+3.25
Ex	38.3±6.1	38.0±6.0	-0.91
HEx	35.7±7.2	34.7±5.9	-2.15

Values are expressed as mean±SD. C (n=9), H (n=10), Ex (n=9) and HEx (n=9)

**p<0.05 significantly different from pre test value*

#p<0.05 significantly different from H group

Antioxidant enzyme: Superoxide Dismutase (SOD)

Figure 1 presents the mean values of blood superoxide dismutase (SOD) for each group at pre- and post-tests. The mean serum SOD levels did not show a statistically significant interaction between time and treatments (*df*=3, *F*=1.853, *p*=0.157). Likewise, there were no significant main effects of time (df=1, *F*=0.030, *p*=0.864) and main effect of intervention (*df*=3, *F*=0.653, *p*=0.587) on mean SOD.

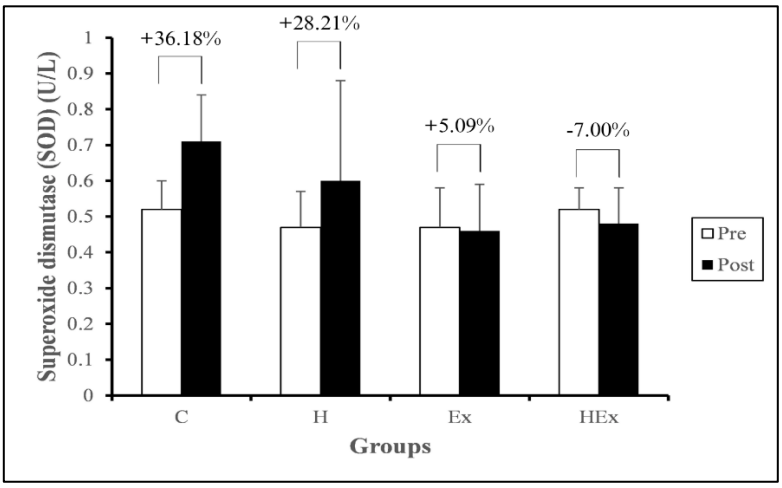
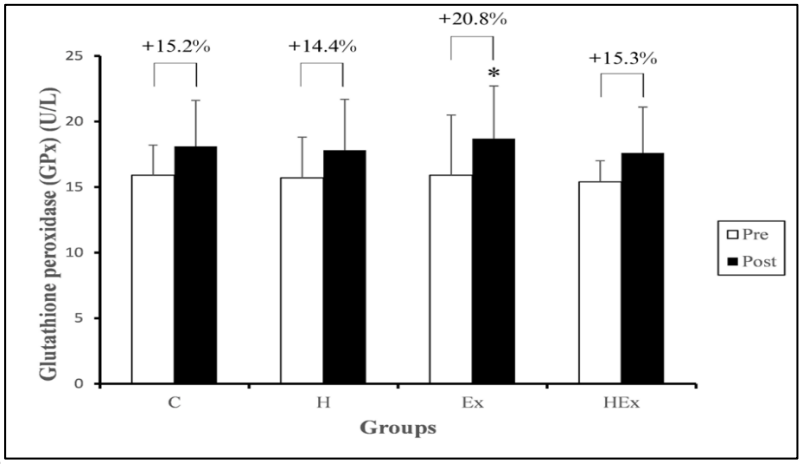


Figure 1: Participants' Superoxide Dismutase (SOD) Activity at Pre- and Post Tests (Mean±SD)

Antioxidant enzyme: Glutathione Peroxidase (GPx)

Figure 2 shows the mean serum GPx for each group before and after testing. The mean serum GPx did not significantly change with time or intervention. (*df*=3, *F*=0.078, *p*=0.971). Similarly, the mean serum GPx showed no discernible main effect of the intervention (*df*=3, *F*=0.128, *p*=0.943). However, there were significant main effects of time on this measured parameter (*df*=1, *F*=18.516, *p*=0.000). Further analysis showed that GPx in the Ex group was significantly higher (*p*=0.016) at post test compared to pre test value. Additionally, it was found that the mean serum GPx in the HEx group tended to significantly rise (*p*=0.05) in comparison to the pre-test values.



**p<0.05, significantly different from pre test value*

Figure 2: Participants' Glutathione Peroxidase (GPx) Activity at Pre- and Post-Tests (Mean±SD)

DISCUSSION

The current study found that there were increased mean body weights following the 6-week trial period at post-test compared to pre-test in control (C), honey (H) and walking exercise (Ex) group. However, increase in body weight was not seen in combined the honey and exercise (HEx) group. The unchanged of body weight with combined honey supplementation and exercise was also documented in a study

carried out on young females by Ooi *et al*. (2011). Similarly, Muhamad *et al*. (2010) also demonstrated that there were no discernible changes in body weight with combined *Eurycoma Longifolia Jack* supplementation and circuit training in adult males.

It was also observed that there were no notable changes following the 6-week study period in percentage body fat in all the groups. These data indicate that honey supplementation, walking exercise or combined honey supplementation and walking exercise did not affect percentage body fat of the 50 to 65 years old postmenopausal women. Similarly, previous study by Ooi *et al*. (2011) also found that honey supplementation alone, aerobic dance exercise alone and combined aerobic dance exercise did not affect body fat in young females with mean ages of 21.9 years old. These results imply that postmenopausal women with age 50 to 65 years old in the present study and young females in Ooi *et al*. (2011) showed similar responses in terms of percentage body fat to honey supplementation alone, walking exercise or aerobic dance alone, and combined honey supplementation with either walking exercise or aerobic dance. However, Sahrir *et al*. (2017) found that oat bran supplementation combined with jogging exercise could significantly reduce the percent body fat of 20.9 years old young men. Collectively, the results of the current study and the aforementioned studies reflect that jogging exercise with higher exercise intensity compared to walking exercise and aerobic dance, when combined with nutritional supplementation, may elicit a greater effect in reducing body fat.

High-reactivity chemicals known as free radicals are naturally created by the body's metabolic processes. High concentrations of free radicals' damage nucleic acids, membrane lipids, and cell proteins, ultimately resulting in cell death. Numerous chronic diseases, such as atherosclerosis, cardiac failure, autoimmune diseases, cell damage, and diabetes, are largely caused by free radicals. In a healthy state, the body's antioxidant defense mechanism blocks the generation of free radicals and stops their deleterious effects (Yarmohammadi & Abdi, 2014; Deniz & Aksoy, 2025). Antioxidants have been hypothesised to reduce oxidative damage by directly scavenging reactive oxygen species from degrading the cell's lipids, proteins, and nucleic acids and by activating chemical reactions to detoxify free radicals within cells (Gomez-Cabrera *et al*., 2005). Fadzel *et al*. (2018) have reported that an 8-week supplementation of bee bread at a daily dose of 20 grams could enhance the serum total antioxidant status in recreational athletes.

All four groups in the current investigation showed no discernible changes in serum superoxide dismutase (SOD) following the intervention period. This present finding showed that honey supplementation, walking exercise and their combination did not seem to increase the SOD level at the dosage of honey and walking programme prescribed.

A previous study by Shafin *et al*. (2014) also indicated that there was no notable change in mean SOD activity in postmenopausal women consuming 20g tualang honey for 16 weeks. This result was similar to our finding that SOD was not changed significantly after 6 weeks. Collectively, Shafin *et al*. (2014) and the present study found postmenopausal women's SOD activity was not significantly affected by 20g of tualang honey ingestion.

The unchanged in serum SOD was also demonstrated in a previous study by Na'aim *et al*. (2022) who examined the effects of combined resistance training and bee pollen on antioxidant status among young males. Their results demonstrated that serum superoxidase dismutase (SOD) did not alter in response to resistance training alone, bee pollen supplementation, or resistance training plus bee pollen supplementation. Azizbeigi *et al*. (2014) also demonstrated that there was no significant difference between SOD activities after 8 weeks of endurance training, resistance training, and concurrent training among 30 untrained men.

In several previous studies with different nutritional supplementation, different exercise mode and different gender from the present study have shown that SOD activity was increased after the intervention period. Wadiah *et al*. (2015) reported that SOD activity was increased after chocolate malt drink ingestion combined with aerobic dance exercise for 8 weeks in young females. A study by Sahrir *et al*. (2017) demonstrated that 8 weeks of oat bran supplements combined with jogging exercise among young sedentary males was beneficial in increasing SOD level significantly.

It has been suggested that physical activity increases the production of reactive oxygen species (ROS) in skeletal muscle, and that exercise training may strengthen antioxidant defense systems that are both enzymatic and nonenzymatic. Radak *et al*. (2013) reported that, regardless of age, endurance exercise has a positive protective effect against oxidative damage. Neverthless, the present study found that 6 weeks of walking exercise alone, and combined walking exercise with honey supplementation did not affect antioxidant enzyme of SOD significantly in 50 to 65 years old postmenopausal women. The disparity between the study's conclusions of Wadiah *et al*. (2015), Sahrir *et al*. (2017) and the present study could be attributed to age factor, in which young males and females were recruited in their studies, and older women with age 50 to 65 years old were recruited in the present study. Furthermore, variations in the type of exercise, length of the intervention, participants' fitness level, and the kind of nutritional supplement may have contributed to the discrepancies between the current study's findings and those of earlier research.

In the present study, control group (C) and honey alone group (H) did not significantly affect serum glutathione peroxidase (GPx). Nevertheless, walking exercise alone (Ex) and combined honey and exercise group (HEx) seem to have a positive effect on GPx level. This is based on the observation that GPx level was significantly higher (p=0.016) at post test compared to pre test value in the Ex group. It was also found that HEx group tended to a significant increase (p=0.05) in GPx compared to its pre test value.

According to a prior study by Wadiah *et al*. (2015), young females' antioxidant enzyme levels were raised by aerobic dance exercise alone (Ex) and by consuming chocolate malt beverages in conjunction with aerobic dance exercise (CmdEx). In their study, the main effect of time on GPx activity was statistically significant for both the Ex (F=13.493, p<0.05) and CmdEx (F=13.493, p<0.01) groups from the pre-test to the post-test. Subsequent analysis revealed that the Ex and CmdEx groups' GPx activity values were noticeably higher at post-test than in the pre-test.

Miyazaki *et al*. (2001) revealed that participants who ran at a high intensity of 80% of their maximum heart rate had significantly higher GPx. Yarmohammadi and Abdi (2014) reported that moderately intense aerobic exercise could also greatly raise the levels of antioxidant enzymes; i.e., women with type-2 diabetes who participated in aerobic exercise had significantly higher plasma GPX levels than those in the control group. The authors mentioned the prescribed aerobic exercise program can elicit beneficial effects on the body's antioxidant defense system in adult women with type-2 diabetes, based on the fact that it improves the antioxidant defence of the body by elevating the levels of certain plasma antioxidant enzymes. Similarly, the present study also found that moderate-intensity walking exercise alone could significantly increase the antioxidant enzyme of GPx in 50 to 65 years old postmenopausal women.

The current study's limitations are: 1) the participants' daily diet was not closely monitored and 2) the intervention period was short, i.e. 6 weeks. It is recommended that for further studies, participants' daily food intake to be recorded. Additionally, interventions with longer durations and increased exercise frequency are recommended. To further validate the effectiveness of the intervention, future studies could also measure oxidative stress markers in conjunction with antioxidant enzyme levels.

Conclusion

In conclusion, this study investigated the impact of 20g of honey consumption, walking exercise, and their combined effects on antioxidant enzyme activity in postmenopausal women aged 50 to 65 years. While neither honey supplementation nor walking exercise alone significantly impacted superoxide dismutase (SOD) activity, the results revealed that a structured walking program significantly increased glutathione peroxidase (GPx) activity. This underscores the potential of moderate-intensity exercise as a valuable approach for improving antioxidant enzyme levels which are essential for decreasing oxidative damage and promoting overall health in postmenopausal women. The observed trend of a significant increase in GPx activity with combined honey supplementation and walking exercise further suggests that integrating nutritional supplementation with physical activity may provide additional benefits.

The methods developed in this study can be applied more broadly to formulate guidelines for exercise and nutrition promotion programs designed to improve antioxidant defenses in similar populations. By establishing a foundation for future research, this article encourages further investigation into the synergistic effects of dietary interventions and physical activity on oxidative stress and overall health in postmenopausal women. Future studies could expand on these findings by investigating different dosages, durations and types of physical activities, as well as varying dietary supplements to optimise health outcomes in this vulnerable population.

Conflict of Interest

The authors affirm that they have no conflicting interests.

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