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台灣女性之飲食型態與骨質密度關聯性研究

Association of Dietary Pattern with Bone Mineral Density in Taiwanese Women

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本論文係許梧菘君（學號 R00849034）在國立臺灣大學流行病學及預防醫學研究所完成之碩士學位論文，於民國 102 年 7 月 10 日承下列考試委員審查通過及口試及格，特此證明

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中文摘要

背景

飲食與骨質疏鬆症有密不可分的關係，過去探索飲食型態與骨質密度的研究相當稀少且結果並不一致。由於停經對於骨質密度的影響甚鉅，但以往並無研究同時探討及比較停經狀態對於不同飲食型態與骨質密度關係的影響。同時，飲食型態和其他風險或保護因子之交互作用對於骨質密度的影響並不清楚。

方法

此研究為橫斷性設計，於 2009 至 2010 年間，招募了 1,567 位年齡介於 40 及 55 歲至台北美兆健康檢查中心參加健康檢查的台灣女性。腰椎骨質密度使用雙能量放射線儀測量;飲食型態的資料則使美兆健檢的自填 25 題半定量飲食問卷收集，再利用因素分析找出對於骨質密度解釋力最強的幾種飲食型態。接著依總人數將因素分數切為三組(高、中、低)，依此分數來比較不同攝取量與骨質密度的相關。此外，本研究亦進行分層分析，以探討停經狀態與其他風險或保護因子如何影響飲食型態與骨質密度之關係。

結果

本研究發現，女性之「蔬菜與水果」攝取為中等量時，有保護骨質密度過低的風險(調整後勝算比= 0.66, 95%信賴區間= 0.46-0.94)。分層分析發現，以上的關係在停經前(調整後勝算比= 0.58, 95%信賴區間= 0.39-0.86)、正常身體質量指數(大於 18.5 到小於 24 kg/m^2：調整後勝算比= 0.62, 95%信賴區間= 0.41-0.93)、不喝酒(調整後勝算比= 0.64, 95%信賴區間= 0.44-0.92)、不抽菸(調整後勝算比= 0.67, 95%信賴區間= 0.47-0.97)或無規則運動習慣的女性(小於每次 30 分鐘且每週少於 3 次：調整後勝算比= 0.43, 95%信賴區間= 0.26-0.71)依舊存在。除此之外，若女性抽菸且攝取中等量的「醃製醬菜與泡麵」，其低骨質密度風險顯著上升(調整後勝算比= 8.74, 95%信賴區間= 1.43-53.43)。

結論

中等「蔬菜與水果」形態的攝取能保護骨質密度過低，此關係在尚未停經、正常身體質量指數、不喝酒、不抽菸或無規則運動的女性依然存在。然而，攝取中等量之「醃製醬菜與泡麵」型態的吸菸女性，低骨質密度的風險則會升高。

關鍵詞：飲食型態、骨質疏鬆症、女性、停經

Abstract

Background

Diet has been closely associated with osteoporosis. Few studies have explored the associated between dietary pattern and bone mineral density (BMD) and results were inconsistent. It is well known that menopausal status has a great impact on BMD, however, no study include both pre- and postmenopausal women and compare how menopausal status affect the association between dietary pattern and BMD. Meanwhile, it is unclear how some risk or protective factors modify the association above.

Material and Methods

This is a cross-sectional study. A total of 1,567 women aged 40 to 55 were recruited from MJ Health Management Institution in Taipei, Taiwan (2009-2010). Bone mineral density (BMD, g/cm^2) was measured at lumbar spine by using dual-energy X-ray absorptiometry. Based on a 25-question semi-quantitative food frequency questionnaire, factor analysis was performed to identify dietary patterns that can well explain the variation of BMD. Factor score of each food item was tertiled (high, medium, low) to explore the association between factor score and BMD. In addition, stratified analyses were performed to explore how menopausal status, other risk or protective factors affect the association between dietary patterns and BMD.

Results

Medium “vegetables and fruits” pattern protects against low BMD in women [adjusted OR (AOR) = 0.66, 95% confidence interval (CI) = 0.46-0.94]. After stratification, the association above remains significant among premenopausal women (AOR = 0.58, 95% CI = 0.39-0.86), women with normal BMI (18.5 to < 24 kg/m^2: AOR = 0.62, 95% CI = 0.41-0.93), women who are non-drinkers (AOR = 0.64, 95% CI = 0.44-0.92), never-smokers (AOR = 0.67, 95% CI = 0.47-0.97) or lack of regular exercise (< 30 minutes/time and < 3 days/week, AOR = 0.43, 95% CI = 0.26-0.71). In contrast, medium “salted pickles and instant noodles” pattern is associated with low BMD among smoking women (AOR = 8.74, 95% CI = 1.43-53.43).

Conclusions

Medium “vegetables and fruits pattern” protects against low BMD. This association remains in premenopausal women, women with normal BMI, or women who are non-drinkers, never smokers, or lack of regular exercise. In contrast, medium “salted pickles and instant noodles” pattern is associated with low BMD among smoking women.

Keywords：dietary pattern, osteoporosis, women, menopause

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Chapter 1. Introduction

1.1 Importance of osteoporosis

According to reports from World Health Organization, osteoporosis is an important public health issue that secondary to cardiovascular disease. Osteoporosis is a silent disease and characterized by a low bone mineral density (BMD) and fragility of bone tissue [1]. Taiwan has become an aging society (> 7% elderly in the population based on the criteria of World Health Organization) since 1993 [2]. Osteoporotic fractures have been related to disability, loss of quality of life and increasing mortality [3]. The most common fractures happens in vertebrae and hip [3]. In the United States, more than 2 million people have fractures, which cost nearly $17 billion in 2005, and this number will increase 50% by 2025. In addition, the prevalence of osteoporosis among women aged 50 years or older was highest in Mexican American (19.3%), followed by non-Hispanic whites (9.7%) and non-Hispanic blacks (4.3%) between 2005 and 2008 [4].

Among non-whites, the burden of osteoporosis is growing up quickly as well [5]. In Taiwan, the prevalence of osteoporosis was 23.9% and 38.3% among men and women aged 50 or older, respectively, in 2005-2008 [6]. In Korea, the prevalence of osteoporosis was 13.1% and 24.3% among men and women aged 40 or older, respectively [7]. Therefore, it is important to explore the risk of osteoporosis at an early age of women.

1.2 **Risk and protective factors for low bone mineral density**

Several factors may influence the BMD and can be separated into modifiable and non-modifiable factors [8]. Non-modifiable factors include gender, age, skeletal built, genetics, menopausal status, and ethnicity. Modifiable factors include estrogen status and lifestyle style factors (e.g., physical activity, smoking, alcohol consumption, and diet, etc.). Among them, menopausal status has known to have great impact on BMD. In addition, low body weight, sedentary life style, smoking and alcohol drinking have also known to deteriorate BMD. The complex interactions between these factors may change both the development to peak bone mass and age-related bone loss [8]. Therefore, it is important to consider the effect of these factors while doing research related to BMD or osteoporosis.

1.3 **Nutrients and phytochemical with bone health**

Many nutrients and phytochemical could influence bone health, including calcium, protein, manganese, copper, zinc, vitamin K, vitamin C, vitamin D and vitamins B12, etc [9-16]. Among them, protein, calcium and vitamin D are important constituents for bone tissue [13, 17]. It is known that dietary intake could affect directly or indirectly bone metabolism and structure via different mechanisms [18]. An example of direct effect is protein intake positively correlated with BMD as it is an important to the growth of bone skeleton [19]. A Utah study found that increased protein intake was associated with a decreased risk of hip fracture in both men and women aged 50 to 69 years old [20]. An example of indirect effect is calcium intake, which is associated with the level of parathyroid hormone and thus affects bone remodeling rate [18]. Because calcium can facilitate optimal peak bone mass at early age and slow down bone loss at later age, adequate dietary calcium intake is important to people at all age

[21]. In postmenopausal women, decline of sex hormone levels and change of nutrition status are correlated with bone remodeling, which is related to bone fragility and the subsequent fracture risk [18]. In addition, vitamin D is an important factor to BMD as it influences the mineralization of the skeleton. The activation of vitamin D metabolite $1,25(OH)^2D$ can open calcium channels, stimulate the absorption of calcium from gastrointestinal tract, and thus maintain BMD. In sum, previous studies found that some nutrients, particularly calcium, vitamin D and protein, are related to bone health [18].

1.4 **Dietary pattern**

Different approaches were used to analyze dietary pattern, e.g., factor analysis, cluster analysis, and dietary indices [22]. This study adopted factor analysis to group food items into different dietary patterns. Past studies focused on the association between specific nutrients or phytochemical and BMD or osteoporosis and findings were inconsistent. It is possible that the approach of using candidate nutrients or food items may not be appropriate. This is because our daily diet is consisting of different foods with mixed nutrients and thus a health issue is attributable to dietary pattern via the integrated effects and interactions of nutrients and food items [22-25]. In addition, test lots of food items or nutrients individually may lead to chance finding due to the inflation of type I error [26]. In brief, dietary pattern includes a variety of foods and nutrients, and thus allow us to give a global view on disease prediction, which is difficulty to be explained by limited food items and nutrients [22].

Because osteoporosis is a complex disease, dietary patterns can not only identify a group of food items and the corresponding nutrients [27], and can also give us a global view on diet which offers a better explanation of the risk of osteoporosis.

1.5 **Dietary indices**

Several dietary indices, e.g., DASH diet, Okinawa diet, and Mediterranean diet, have been proposed to evaluate the overall diet quality [28]. These dietary indices are created based on dietary recommendations [28]. Below is brief introduction of these dietary patterns.

DASH diet includes high intake of fruit and vegetables, low intake of animal protein, and sufficient amount of protein from legumes and nuts. This diet index is established for decreasing both systolic and diastolic blood pressure among hypertensive and normotensive people [29]. Okinawa diet, a traditional diet of Okinawans from Japan, is a pattern with high intake of vegetables, legumes and omega-3 fat, moderate intake of fish products and alcohol, low intake of dairy products, meats, saturated fat, and high monounsaturated to saturated fat ratio [30]. This dietary pattern can decrease the risk of cancer and cardiovascular disease [31]. Mediterranean diet is protective against cardiovascular risk factors [32]. This diet is characterized by high intake of fruits, vegetables, legumes, and complex carbohydrates, moderate intake of fish and red wine, and using olive oil as the main source of fats [33].

In Taiwan, some tools were used to access dietary patterns. For example, one study used overall dietary index-revised score and the dietary diversity score to predict mortality of total cancers, diabetes, and pneumonia [34]. The other study revised a global overall dietary quality index (ODI) based on the Taiwanese ‘Food Guides’ and ‘Dietary Guidelines’, and then developed the ODI-R(Revised). ODI-R added a quality assessment for staples and protein-rich foods and reduced the impact of dietary fat quality. After revision, ODI-R provided more sensitivity to assess the nutritional

quality of a diet [35].

The dietary indices above are created for specific health outcome(s) or based on specific diet habit. Although the dietary recommendations are important, it is a global recommendation and thus may not be effective more some specific health issues [22]. Therefore, we need to identify specific dietary pattern for a health concern and for population with specific diet habit.

1.6 **Factors modify the association between dietary pattern and bone mineral density**

Some factors have been related to bone mineral density (BMD) previously. They are menopausal status, body mass index (BMI), smoking, alcohol drinking, and regular exercise. Menopausal status has great impact on BMD as estrogen decline. BMD has little change before menopause but its loss accelerated after menopause with a speed of 0.022 g/cm^2 at spine [36]. In addition, elevated BMI and weight are protective against low BMD and fractures [37]. When BMI or weight increased, the prevalence of osteoporosis and incident fractures decreased [37]. Body weight increased mechanical stress, and the stress stimulated osteoblast activity to maintain BMD [38]. Furthermore, smoking and alcohol drinking may increase the loss of BMD. For example, current smokers showed higher risk of fracture than never-smokers [adjusted odds ratio (AOR) = 2.32, 95% confidence interval (CI) = 1.25-4.33] [39]. Besides, postmenopausal women consuming > 2 drinks/day of alcohol or beer have higher hip and spine BMD. However, men consumed > 2 drinks of liquor/day was associated with decreased hip and spine BMD [40]. In addition, moderate exercise can avoid BMD loss in postmenopausal women as exercise can affect bone turnover to improve bone strength

and inhibit bone loss by mechanical stress [41, 42]. The factors above affect BMD differently and the assessment of interaction between these factors and dietary pattern would help us to elucidate the association between dietary pattern and BMD.

1.7 **Epidemiologic studies relating dietary pattern and bone mineral density**

Previous studies exploring the associations between nutrition or dietary pattern and BMD have been inconsistent [1, 43-45]. A Korean study in adolescents found that the highest tertile of "milk and cereal" dietary pattern was protected against low BMD at lumbar spine (1^{st} vs. 3^{rd} tertile: AOR = 0.36; 95% CI = 0.14-0.93, Table 1) [46]. Although menopausal status has known to influence the level of BMD via the change of sexual hormone, most previous studies included postmenopausal women only and thus do not allow us to compare different association between pre- and postmenopausal women. A co-twin study found that Traditional English dietary pattern, including high intake of fried fish, fried potatoes, legumes, red meats, processed meats, savory pies and cruciferous vegetables, was inversely associated with BMD of the hip neck (β = -0.055, p = 0.01, Table 1) [47]. Another study found that women with high intake of "high acid-forming food", including high-fat dairy products, organ meats, red and processed meats and non-refined cereals, had increased risk of low spinal BMD (AOR = 2.29; 95% CI = 1.05-4.96, p = 0.04, Table 1) [45]. In addition, women with high intake of French fries, mayonnaise, sweets, desserts and vegetable oil had increased risk of low femoral neck BMD (AOR = 2.83, 95% CI = 1.31-6.09, Table 1) [45].

Most of previous studies have put emphasis on postmenopausal women, therefore, only few studies explored dietary patterns in relation to BMD in premenopausal women and the elderly. A study found that “healthy pattern”, which included green, dark yellow vegetables, mushrooms, fishes ,and fruits, was positively associated with BMD level in premenopausal women ($p = 0.048$) [48] (Table 1). Framingham study found that “fruit, vegetables, and cereal” pattern was associated with better BMD in men ($p = 0.05$) and “candy” pattern was associated with lower BMD in both old men and women [49].

1.8 **Aims**

Nutrition status plays an important role in osteoporosis. As compared with specific nutrients or food items, dietary patterns could capture the global nutrition status and thus may be better predictor of BMD level as compared with nutrients or food items. Previous studies have been inconsistent in relating dietary pattern to BMD. The difference between dietary patterns may be due to different diet habit and different food across geographic regions. Only few Asian studies and no Chinese studies have been done before. In addition, menopausal status is an important predictor of BMD level. However, only one past study explored dietary pattern and BMD in premenopausal women alone, which does not allow the comparison between pre- and post-menopausal women. Therefore, this study was aimed to explore the association of dietary pattern and the risk of low BMD in middle-aged women. This study also tries to clarify how different risk or protective factors affect this association, which has not been wide explored.

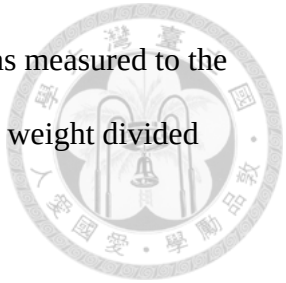
Chapter 2. Material and Methods

2.1 **Study population**

This was a cross-sectional study. A total of 1,567 Taiwanese women, aged 40 to 55 years old, were recruited from MJ Health Management Institution, Taipei, Taiwan, between October 2009 and August 2010. Each participant filled out a self-reported questionnaire and provided a blood sample. The outcome of this study was BMD (g/cm^2) at lumbar spine. Participants with the following conditions or disease were excluded (n = 279): (1) disease known to affect BMD levels (e.g., hyperparathyroidism, hyperthyroidism, liver cirrhosis, n = 10), (2) take hormone or steroid that may affect BMD (n = 67), (3) lack of BMD at lumbar spine (n = 85), (4) lack of data on semi-quantitative food frequency questionnaire (FFQ, n = 55), (5) vegetarian (n = 48), and (6) irrational daily energy consumption [50] (<500 or >3,500 kcal/day, n = 14). A total of 1,288 women were included for data analysis (Figure 1). Informed consent was obtained from each participant. The study protocol was approved by the institutional review boards of MJ Health Management Institution and College of Public Health, National Taiwan University.

2.2 **Data collection**

A self-report questionnaire was administered to collect information of diet, life style (e.g., smoking, alcohol consumption, and calcium supplement), menopausal status, disease history (e.g., hypertension, thyroid disease and diabetes), and medication history (e.g., hormone and steroid).



Body weight (kg) was measured to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm. Then, body mass index (BMI) was estimated by body weight divided by the square of height (kg/m^2).

2.3 **Measurement of bone mineral density**

BMD (g/cm^2) was measured at the lumbar spine by using dual-energy X-ray absorptiometry (DXA, GE Lunar Health Care, DPX-L, USA), which was calibrated by a standard automated test program provided by manufacturer. BMD was tertiled (T1, T2, and T3) based on the whole population. High BMD was defined as T2 plus T3 (reference group) and low BMD was defined as T1 (comparison group).

2.4 **Reproducibility and validity of MJ dietary questionnaire**

The reproducibility of the questionnaire was evaluated by using diet data from people who had health checkup at MJ Management Institution between 1996 and 1998. The intake of nutrients was estimated by questionnaires (Appendix 1), and the intraclass correlation coefficient (ICC) of nutrients are between 0.4 and 0.7 [51]. In addition, the validity of this study was assessed by comparing our data with data from Nutrition and Health Survey in Taiwan (NAHSIT) between 2005 and 2008. The estimated dietary intake of protein, fat, carbohydrate, and calcium is 53.5, 31.8, 229 g/day and 487.8 mg/day, respectively, based on MJ dietary questionnaire, which is approximately 75%, 55%, 105%, and 87% of the amount estimated in NAHSIT. This questionnaire didn't collect information on nuts, processed products and type of oil and thus the intake of fat tend to be underestimated in this study. In addition, the intake of protein and calcium, which are important to BMD, in this study, is about 75% and 87%,

respectively, of the amount estimated in NAHSIT. Moreover, one study modified the MJ dietary questionnaire into a semi-quantitative food frequency questionnaire with 31 items and validated dietary folate and vitamin B6 intakes by using their blood data. The Spearman rank correlation coefficients were 0.34 and 0.31, respectively [52]. In sum, the reproducibility and validity of the dietary questionnaire used in this study is acceptable.

2.5 **Dietary assessment**

Dietary intake was assessed by a self-reported semi-quantitative food frequency questionnaire (25 questions) based on regular dietary habit. The information of united serving, e.g., 1 cup of milk is equal to 240 c.c. and the width of a bow is 16 cm, which is defined by MJ questionnaire. Participants recorded their frequency of consumption for each food item on daily or weekly basis. After data collection, these dietary data were transformed into daily unit serving and daily macronutrients intake for further analyses and validation purpose. Nutrient intakes were estimated from the dietary questionnaire by using the food composition database of Food and Drug Administration in Taiwan (http://consumer.fda.gov.tw/FoodAnalysis/index.htm). The amount of one portion of food or macronutrient (unit: gram) is estimated by summing up each food item in grams [53]. An examples of estimating daily unit serving and daily macronutrients intake is as below.

Question: How often did you eat an egg?

Answer: 1-3 times per week.

Daily unit serving = (2 serving/week) * (52 week/year) / (365 day/year) = 0.28 serving/day

Protein per 100 grams of egg = 12.1 g (i.e., 1 gram of egg contains 0.12 g protein)

One portion of an egg = 65 g

Daily protein intake from an egg = 0.28 * 0.12 * 65 = 2.2 g/day

2.6 **Statistical analyses**

Student's t test (for normally-distributed continuous variable), Mann-Whitney U test (for non-normally-distributed continuous variable) and Pearson's chi square test (for categorical variables) were performed to compare the distribution of potential confounders by high and low BMD levels (T2 plus T3 vs. T1).

The scree plot was used to determine the number of components retained for further analyses. After factor analysis with varimax orthogonal rotation, these components become a simple structure with greater interpretability. Factor loading indicates the correlation between individual food groups and dietary patterns [48]. A food item with ｜factor loading｜ ≥ 0.40 indicates significant contribution to specific dietary pattern. A high factor score for a given pattern showed high intake of the foods, and vice versa [54]. Each pattern was named by food items with high factor loading. Factor scores were tertiled (high, medium, and low) based on the distribution of each dietary pattern in the whole population.

After the determination of dietary patterns by factor analysis, ANOVA test (for normally-distributed continuous variable), Kruskal-Wallis H test (for non-normally-distributed continuous variable) and Pearson's chi square test (for categorical variables) were performed to compare the distribution of potential confounders across different dietary patterns.

For multivariable analysis, logistic regression model was used to estimate odds ratio (OR) and 95% confidence intervals (CIs) in women with low BMD (T1) versus high BMD (T2 plus T3) for dietary pattern. Potential confounders [e.g., age, menopausal status (yes/no), BMI (kg/m^2), smoking (yes/no), alcohol consumption (yes/no), calcium supplement (yes/no), regular exercise ($\geq$ 30 minutes/time and $\geq$ 3 days/week), serum alkaline phosphatase (ALP, IU), and occupation-based socioeconomic status (retired or no job/blue-collar/white-collar/self-employed and academic or professional/lifetime housekeeping/others) were adjusted in the models. To analyze if any trend exist as the factor score increase one unit, the medium of factor score in each tertile were used in the logistic regression model.

Effect modification by menopausal status (yes/no) was explored by comparing a model with terms for main effects and interaction terms to the model for main effect only using the likelihood ratio test. Stratified analysis was performed to assess the relationship between dietary pattern and BMD by menopausal status, BMI groups and potential confounders. All analyses were performed with SAS 9.2 (SAS Institute, Cary, NC). All statistical tests were two-sided and a *p* value less than 0.05 were considered statistically significant.

Chapter 3. Results

3.1 **Characteristics of the study population**

This study included 1,288 women. The distribution of BMD and BMI were approximately normal (Figure 2 and 3), but the distribution of age was non-normal (Figure 4). As compared with women with high BMD, women with low BMD were older (47.7 vs. 45.6 years old), had a lower BMI (21.6 vs. 22.8 kg/m^2), higher ALP (64.5 vs. 56.6 IU), and included more postmenopausal women (35% vs. 12%, Table 2). The status of smoking, alcohol drinking, regular exercise, calcium supplement, and occupation-based socioeconomic status was similar between high and low BMD.

3.2 **Determination of dietary pattern**

Factor analysis was not performed by menopausal status separately because the number of postmenopausal women is relatively small (n=257). Scree plot showed a turning point when the number of component is 3 (Figure 5). Table 3 demonstrated factor loadings for food or food group of the first 3 components. Dietary pattern 1 “vegetables and fruits” included dark-green and light-green vegetables, fruits, tubers, and whole grains. Dietary pattern 2 “meats, seafood, and oil” included meats, seafood, oil, and eggs. Dietary pattern 3 “salted pickles and instant noodles” included salted pickles, instant noodles, condiments, and organ meats. These dietary patterns explained 30.3% of total variance of dietary intakes (Table 3).

The distribution of pattern 1 was approximately normal (Figure 6-1). This dietary pattern was significantly correlated with daily kilocalorie intake, ever smoking, alcohol consumption, and occupation-based socioeconomic status (age and BMI adjusted Spearman correlation coefficient: 0.55, -0.10, -0.08, and 0.08 respectively, Table 4 and Figure 7). In contrast, the distributions of pattern 2 and 3 were skew to the left (Figure 6-2 and 6-3). These two dietary patterns were significantly correlated with total kilocalorie (age and BMI adjusted Spearman correlation coefficient: 0.54 and 0.42, respectively, Table 4 and Figure 7).

3.3 **Dietary pattern and bone mineral density**

For pattern 1, BMD is fluctuated as factor score increases (Figure 8). In contrast, for pattern 2 and 3, BMD remain stable as the factor scores of increased (Figure 8).

The characteristics of study participants for each dietary pattern were stratified by tertiles (high, medium, and low) of factor score (Table 5, Table 6, and Table 7). Average age and BMI differed significantly over 3 categories of factor scores for pattern 2 and 3. Average ALP, menopausal status, and occupation-based socioeconomic status showed significant difference for pattern 2 only. Smoking status was significantly different for pattern 1. Alcohol consumption was significantly different for patterns 3 only.

Before adjusting other variables, we found that medium intake of pattern 1 and high intake of pattern 2 significantly protect against low BMD (crude OR = 0.69, 95% CI = 0.52-0.93; crude OR = 0.73, 95% CI = 0.55-0.97, respectively, Table 8). After adjusting for age, menopausal status, and BMI, result remained significant for medium

intake of pattern 1 only (AOR = 0.62, 95% CI = 0.45-0.84, Table 8). Further adjustment for alcohol drinking, ever smoking status, calcium supplement, regular exercise, ALP, and occupation-based socioeconomic status has minor effect on the association (AOR = 0.66, 95% CI = 0.46-0.94, Table 8). No significant association was observed for pattern 2 or 3 and low BMD.

For pattern 1, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 9). In addition, high intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 10).

3.4 **Effect modification by menopausal status**

Postmenopause significantly increased the risk of low BMD (AOR = 2.71, 95% CI = 1.76-4.19, Table 9). No interaction was found between menopausal status and dietary pattern on the risk of low BMD (Table 9). However, significant association was found in one subgroup after stratification by menopausal status. Among premenopausal women, medium intake of pattern 1 was protective against low BMD (AOR = 0.58, 95% CI = 0.39-0.86, Table 9). No significant association was observed in other strata.

For pattern 1 by menopausal status, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 11). In addition, high intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 12).

3.5 **Effect modification by BMI groups**

As compare to the normal BMI range, low BMI (< 18.5 kg/m^2) significantly increased the risk of low BMD (AOR = 2.98, 95% CI = 1.64-5.42, Table 10). In contrast, high BMI (≥ 24 kg/m^2) protected against low BMD (AOR = 0.38, 95% CI = 0.26-0.56, Table 12). BMI groups did not significantly modify the association between any dietary pattern and the risk of low BMD. However, significant association was found in one subgroup after stratification by BMI. For women with normal BMI (18.5 to < 24 kg/m^2), medium intake of pattern 1 significantly protected against low BMD (AOR = 0.62, 95% CI = 0.41-0.93, Table 10). No significant association was observed in other strata.

For pattern 1 by BMI groups, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 13). In addition, high intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 14).

3.6 **Effect modification by the status of alcohol drinking**

Alcohol drinking was not associated with low BMD risk. No interaction was observed between alcohol drinking and dietary pattern on the risk of low BMD (Table 11). However, significant association was found in one subgroup after stratification. Among no alcohol drinkers, medium intake of pattern 1 significantly protected against low BMD (AOR = 0.64, 95% CI = 0.44-0.92, Table 11). No significant association was found for other dietary patterns.

For pattern 1 by the status of alcohol drinking, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 15). In addition, high intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 16).

3.7 **Effect modification by the status of ever smoking**

Ever smoking was not associated with low BMD risk. Significant interaction was found between ever smoking and pattern 3 on the risk of low BMD (p interaction = 0.03, Table 12). However, significant association was found in some subgroups after stratification by smoking status. Among never smokers, medium intake of pattern 1 significantly protected against low BMD (AOR = 0.67, 95% CI = 0.47-0.97, Table 12). In addition, among smokers, medium intake of pattern 3 significantly increased the risk of low BMD (AOR = 8.74, 95% CI = 1.43-53.43, Table 12).

For pattern 1 by the status of ever smoking, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 17). High intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 18). In addition, high intake of pattern 3 was proportional to increased intake of other food groups except for vegetables and fruits intake (Figure 19). High intake of pattern 3 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 20).

3.8 **Effect modification by regular exercise**

Regular exercise (≥ least 30 minutes/time and ≥ 3 days/week) was not associated with the risk of low BMD. Significant interaction was found between regular exercise and pattern 1 on the risk of low BMD (p interaction = 0.02, Table 13). No significant interaction was observed for other patterns. After stratification by regular exercise, among women lack of regular exercise, medium intake of pattern 1 showed significant protective effect on low BMD (AOR = 0.43, 95% CI = 0.26-0.71, Table 13). No significant association was found for other dietary patterns.

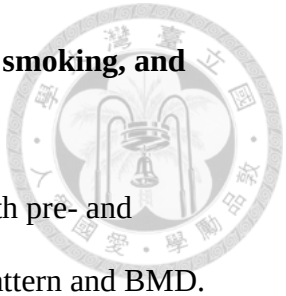
For pattern 1by regular exercise, high intake of pattern 1 was proportional to increased intake of other food groups (Figure 21). In addition, high intake of pattern 1 was also related to high intake of daily protein (g/day) and calcium (mg/day), and showed a positive trend with the different groups (Figure 22).

Chapter 4. Discussions

4.1 **Main findings and comparisons with previous studies**

This study identified three dietary patterns for predicting the risk of low among mid-age Chinese women. These patterns are (1) vegetables and fruits pattern, (2) meats, seafood, and oil pattern, and (3) salted pickles and instant noodles pattern. Medium intake of pattern 1 significantly protects against low BMD. Because only part of the food items were overlapped between our study and the previous one, our finding is partially consistent with two cross-sectional studies [48, 49]. One study reported that ”health” dietary pattern (includes high intakes of green and dark yellow vegetables, mushrooms, fish, and fruits) possitively correlated with BMD among Japanese premenpausal women [48]. The other study found that high intakes of fruits, vegetables, and cereals had significantly elevated hip BMD in old men [49].

In this study, pattern 1 is consisted of dark-green and light-green vegetables, fruits, tubers, and whole grains. Because the intake of these food is associated with high intakes of dietary potassium and magnesium, which could provide an alkaline environment via decreasing renal acid load [55] and thus decreases bone resorption [56] (Figure 23). Therefore, pattern 1 could protect against low BMD. However, we did not observe a dose-response relationship between pattern 1 and low BMD (Table 8). It maybe because the medium intake of pattern 1 has already reached the daily recommendated amount of intake. In addition, the high intake of pattern 1 reflected the increased intake of other unhealthy food (Figure 24), which may also support the U-shape association observed for pattern 1.



4.2 **Effect modification by menopausal status, BMI groups, ever smoking, and alcohol drinking**

To the best of our knowledge, this is the first study including both pre- and postmenopausal women to explore the association between dietary pattern and BMD. After stratification, we found dietary patterns were quite similar between pre- and postmenopausal women. This study found that medium intake of pattern 1 protects against low BMD among premenopausal women. It is possible that estrogen stimulates the apoptosis of osteoclast [57] and thus protects adults' skeleton and maintains the balance between bone formation and resorption (Figure 23) [58]. Because estrogen deficiency leads to bone loss, this may explain non-significant association among postmenopausal women.

Body weight could generate mechanical stress, which increases osteoblast activity [38], to the skeleton. Pattern 1 also protects against low BMD among women with normal BMI (18.5 to < 24 kg/m^2). Low body weight was an important risk factor for low BMD and increased bone loss [59], however, this study did not observe this association. This study also not observed the protective effect of high BMI on low BMD. This may be due to the large amount of postmenopausal women and thus the decline of estrogen counteracts the protective effect of high BMI (Figure 25).

Similar protective effect was observed among non-drinkers for pattern 1. Alcohol consumption could also induce bone loss via osteocyte apoptosis [60]. Therefore, healthy lifestyle may decrease low BMD risk and prevent osteoporosis. In contrast, pattern 3 increases the risk of low BMD among smokers. Because nicotine could decrease BMD via its effect on osteoblast differentiation, this may explain the

increased risk of low BMD among smokers [61]. Smoking has shown to decrease serum osteocalcin concentrations [62] and then increase bone resorption [63]. Due to genetically determined perception of flavors, smokers tend to take salty foods [64]. In addition, high intake of salt decreases renal sodium reabsorption and thus increases the excretion of urinary calcium (Figure 23) [56, 65]. Therefore, the joint effects of smoking and salty foods lead to increased risk of low BMD.

4.3 **Effect modification by regular exercise**

Mechanical factors (e.g. exercise and weight) can stimulate bone cell and thus improve bone strength and decrease bone loss [42]. In this study, medium intake of pattern 1 protects against low BMD among women without regular exercise, which seems contradictory to general perception. It is possible that for women who reporting exercise our population actually involved in very mild exercise. However, for women who did not report regular exercise may actually do a lot of moderate-intensity work (Figure 26). Therefore, limited beneficial effect was observed for regular exercise on BMD.

4.4 **Strengths and limitations**

This study has some strengths. First, the sample size is relatively large as compared with previous studies. Second, this study includes both pre- and postmenopausal women and thus allows us to compare the effect of menopausal status on the association between dietary pattern and low BMD. Importantly, specific dietary pattern (e.g., salted pickles and instant noodles) were identified in this Taiwanese population. This reflects different diet habit exists across ethnic groups, which has not been reported previously.

This study had some limitations. First, this is a cross-sectional study and thus does not allow causal inference for the association between dietary pattern and BMD. In addition, fat is underestimated in the MJ semi-quantitative FFQ as limited questions were included to collect information on fat.

4.5 **Conclusions**

This study found that pattern 1 “vegetables and fruits pattern” protects against BMD. Medium pattern 1 protects against low BMD risk among premenopausal women, women with normal BMI, women who are non-drinkers, never smokers or without regular exercise. Future prospective studies are warranted to explore the causal inferences and to confirm our findings.

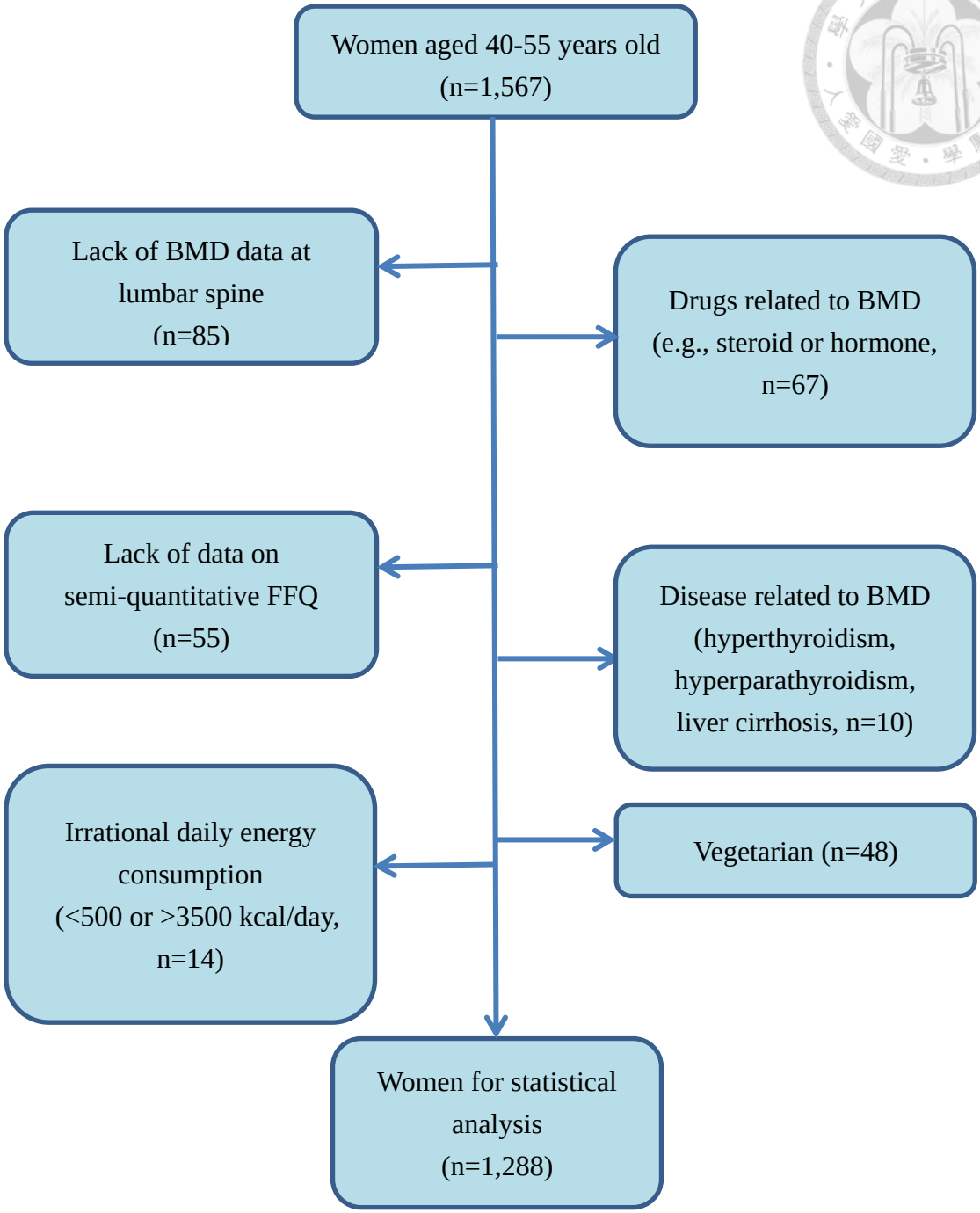


Figure 1. Flowchart of participant recruitment

Abbreviations: BMD, bone mineral density; **FFQ**, food frequency questionnaire.

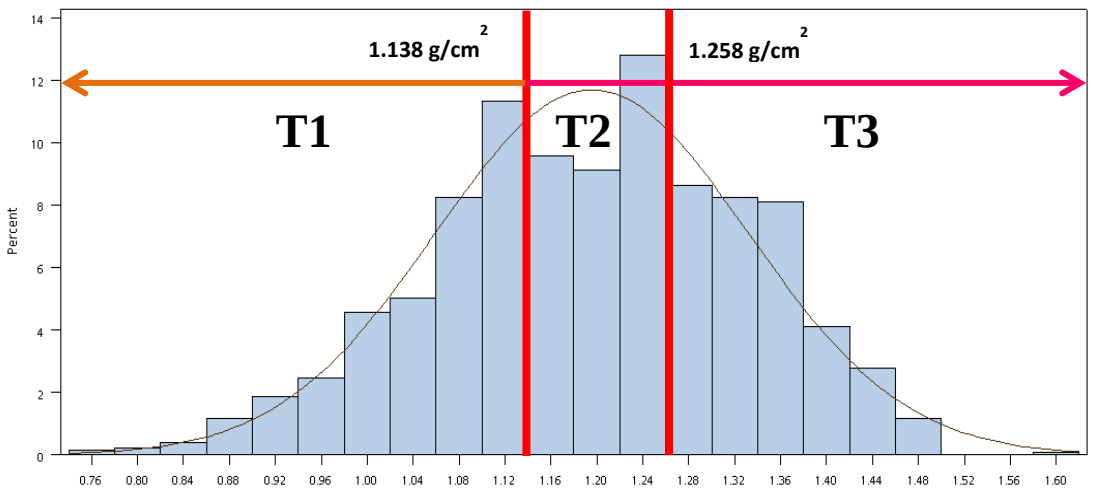


Figure 2. The distribution of bone mineral density of the study population

Bone mineral density was dichotomized into low (1st tertile) and high BMD (2nd and 3rd tertiles, reference group) groups.

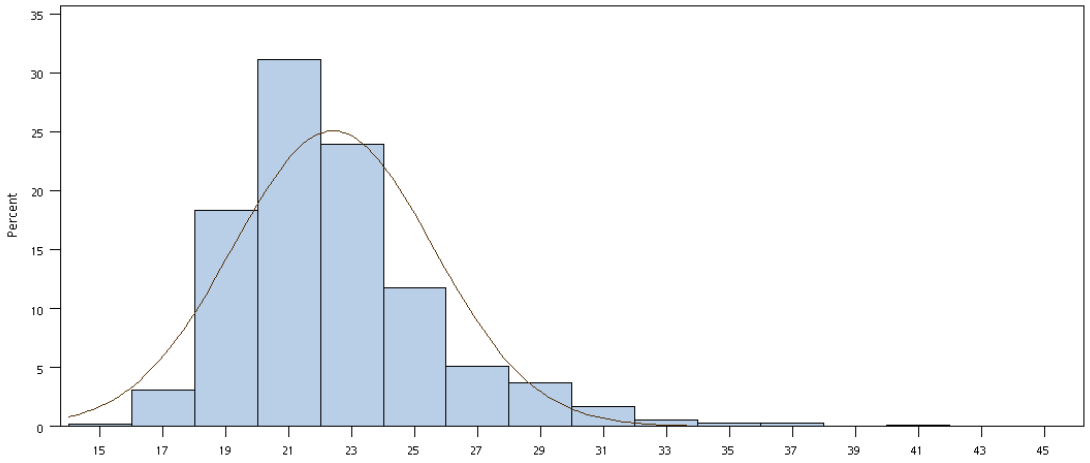


Figure 3. The distribution of body mass index (kg/m^2) of the study population

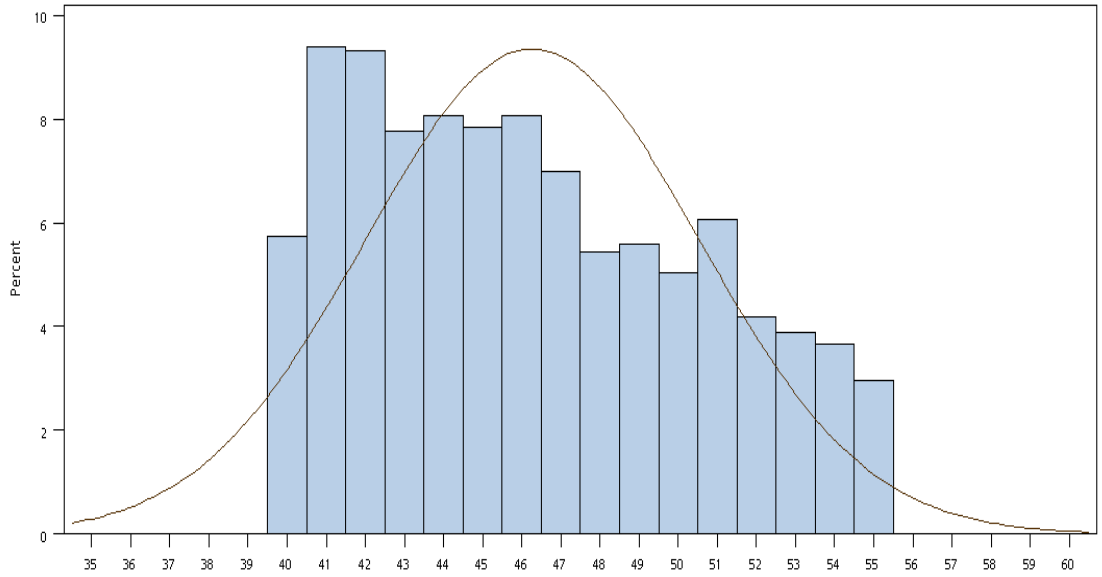


Figure 4. The distribution of age of the study population

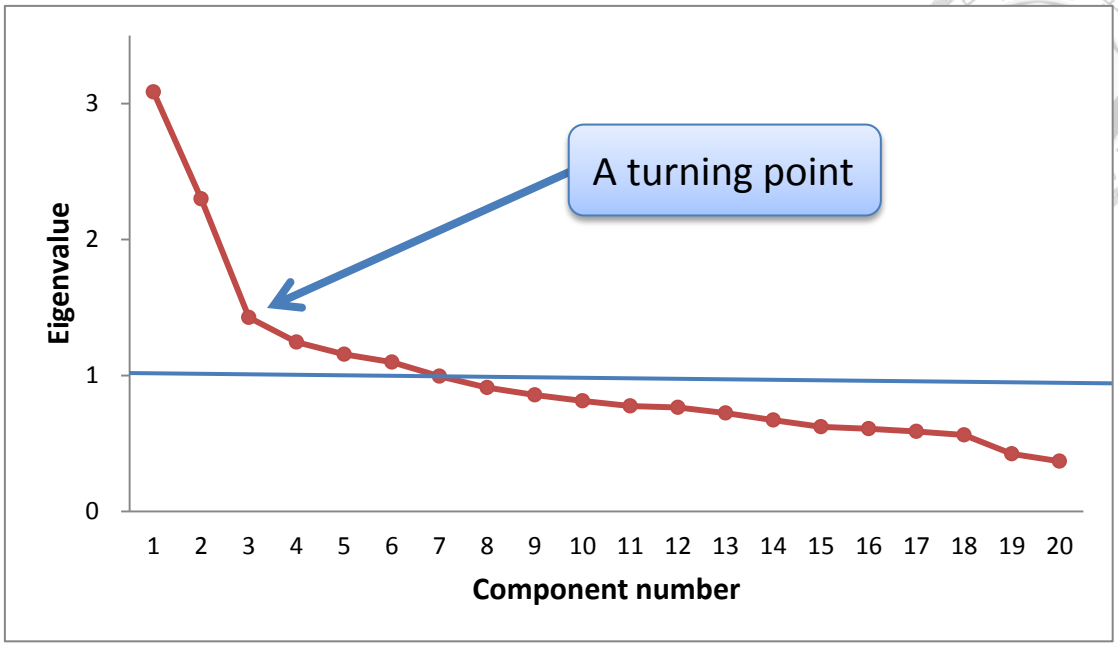


Figure 5. Scree plot from factor analysis

A scree plot shows the trend of eigenvalue. The turning point indicates the maximum number of dietary patterns (n=3) to choose.

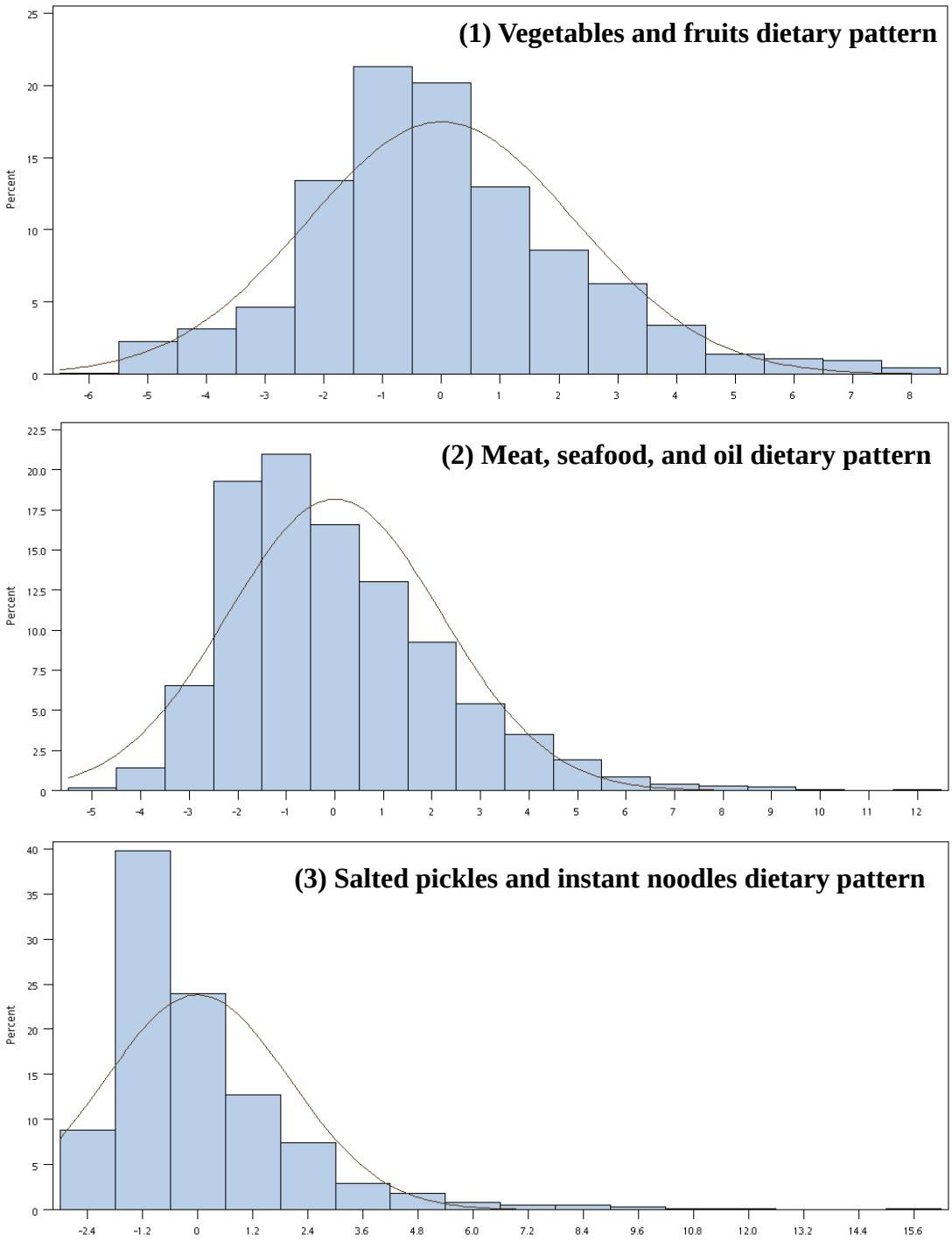


Figure 6. The distribution of factor score for each dietary pattern based on the study population

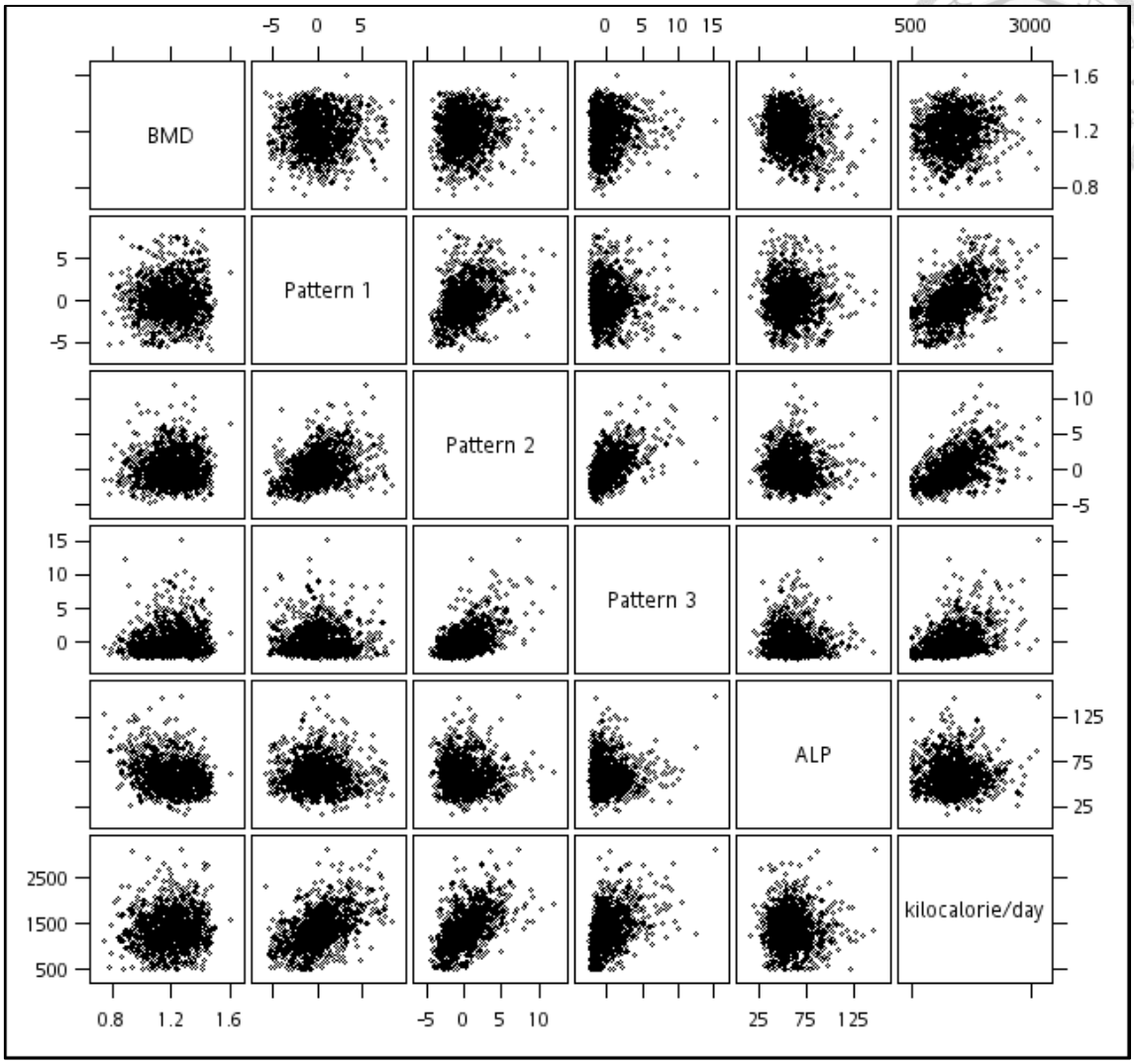


Figure 7. Scatter plots between important variables

Abbreviations: BMD, bone mineral density; **Pattern 1**, vegetables and fruits dietary pattern; **Pattern 2**, meat, seafood, and oil dietary pattern; **Pattern 3**, salted pickles and instant noodles dietary pattern; **ALP**, alkaline phosphatase; **kilocalorie/day**, daily kilocalorie intake.

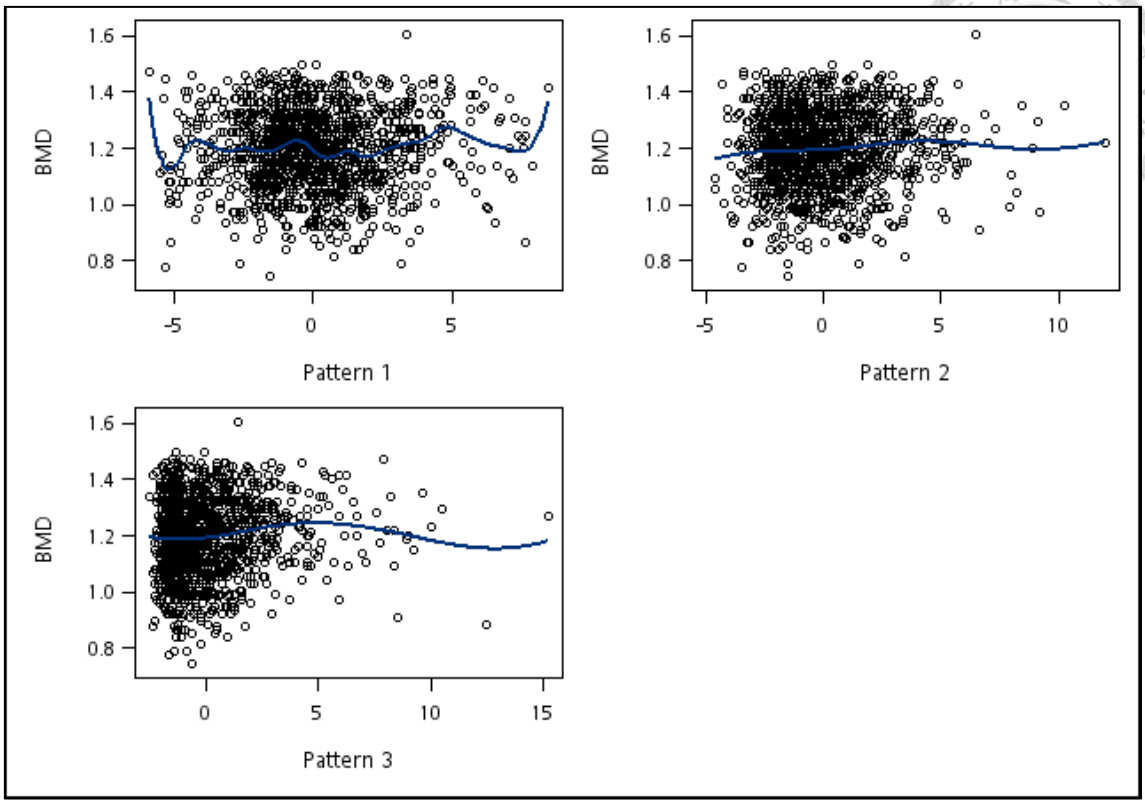


Figure 8. Spline curves of each dietary pattern

Abbreviations: BMD, bone mineral density; **Pattern 1**, vegetables and fruits dietary pattern; **Pattern 2**, meat, seafood, and oil dietary pattern; **Pattern 3**, salted pickles and instant noodles dietary pattern.

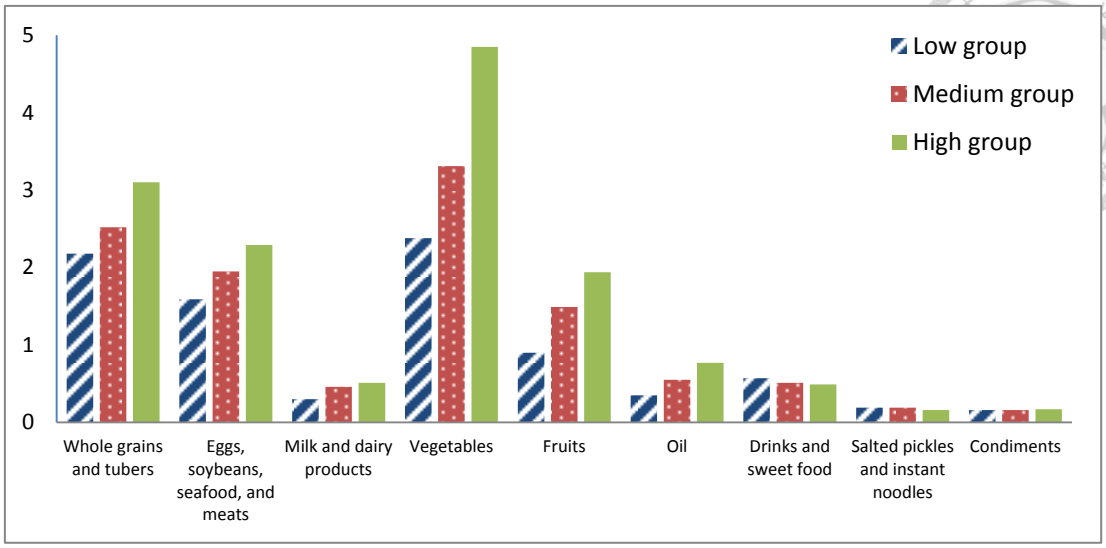
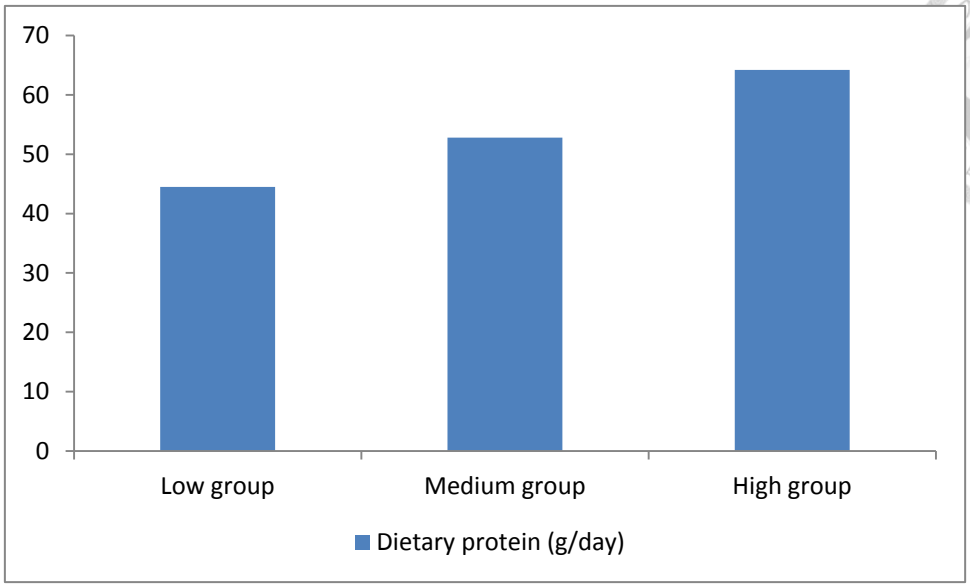


Figure 9. Daily number of servings on pattern 1 by different food groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.



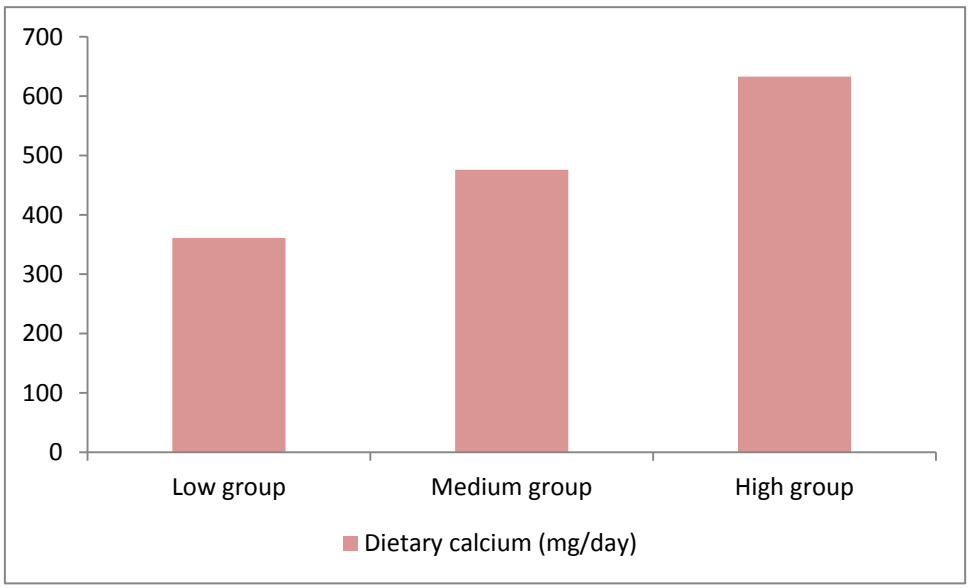


Figure 10. Dietary protein and calcium on pattern 1

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

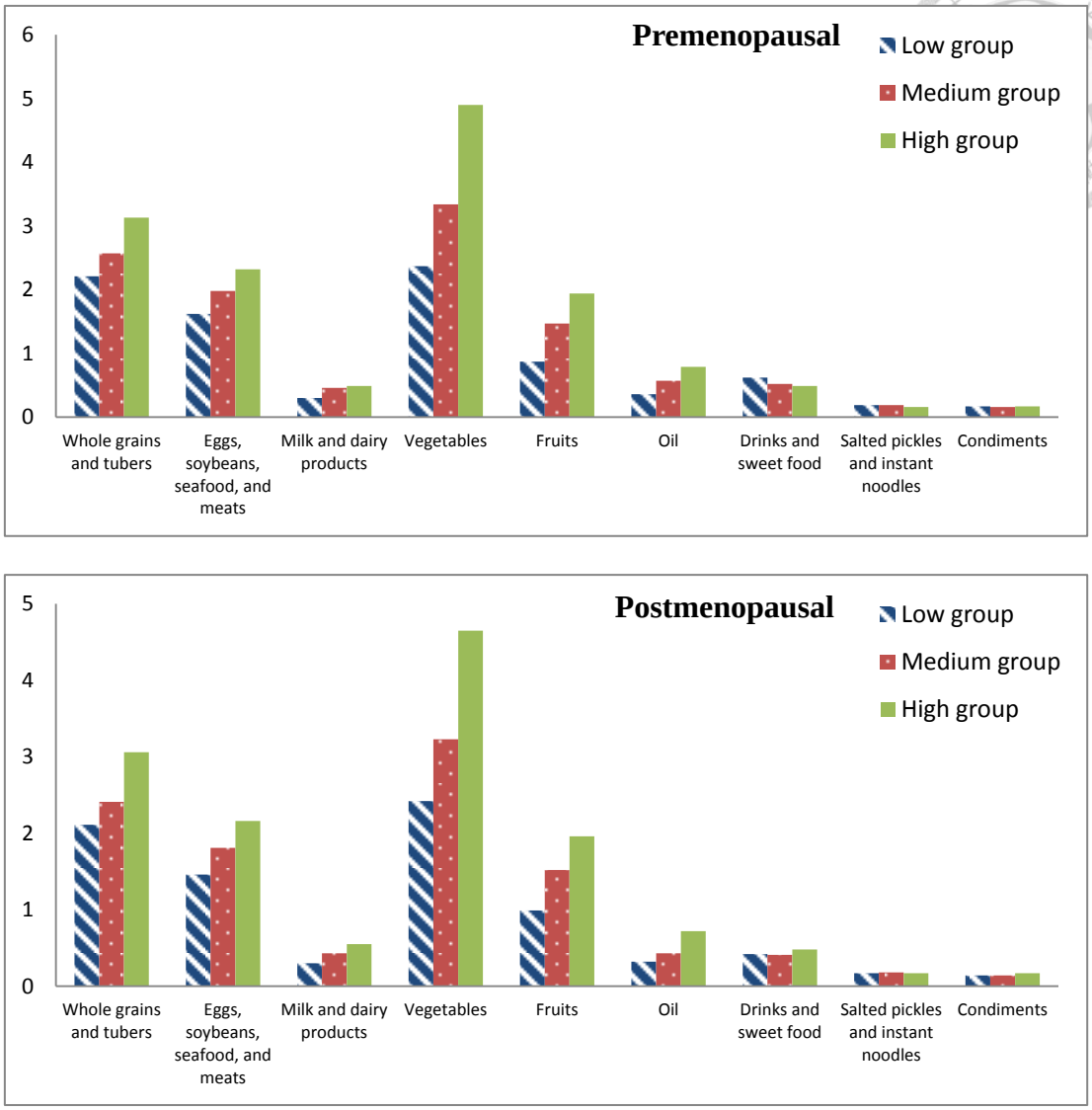


Figure 11. Daily number of servings on pattern 1 by the menopausal status by different food groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

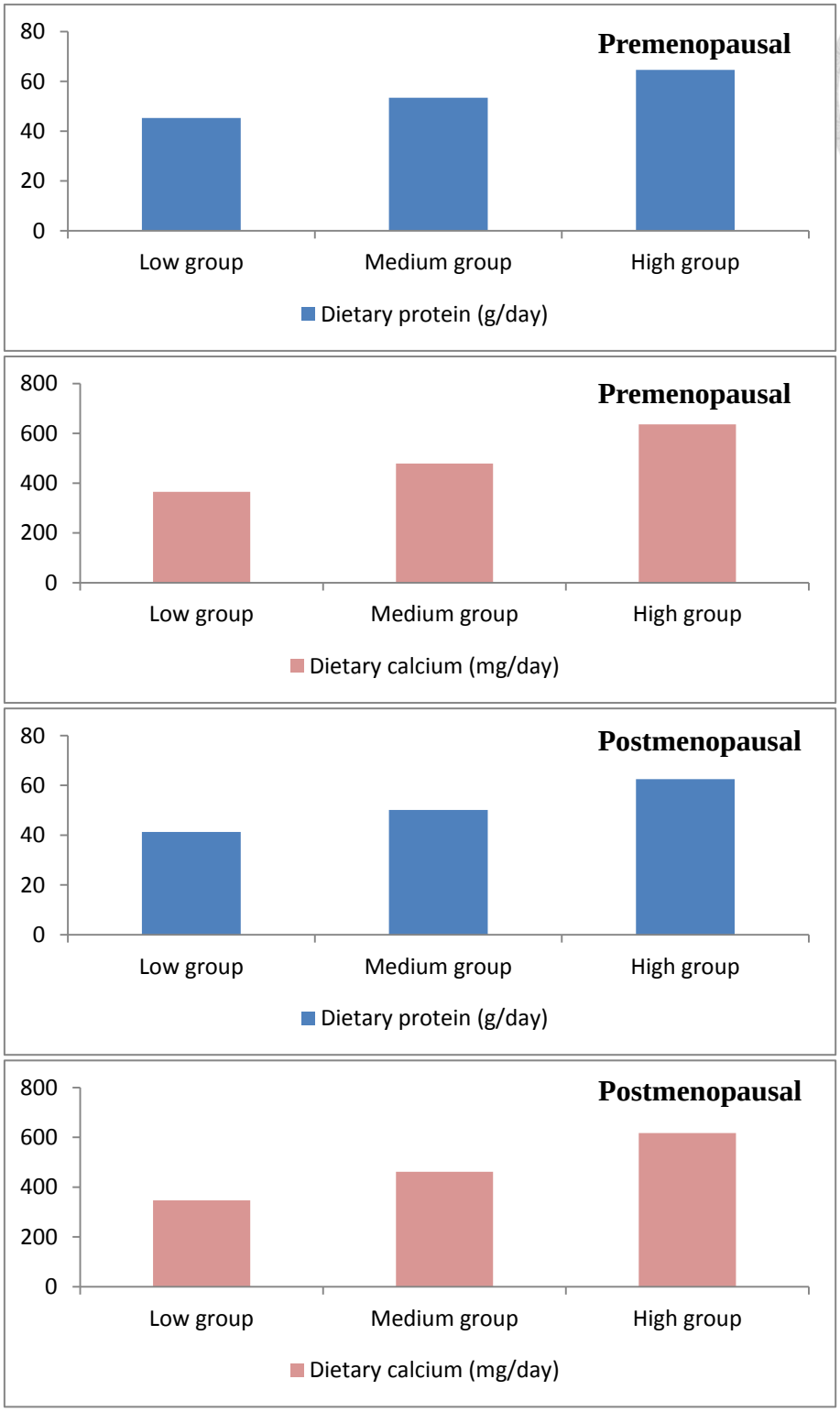


Figure 12. Dietary protein and calcium on pattern 1 by the menopausal status

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

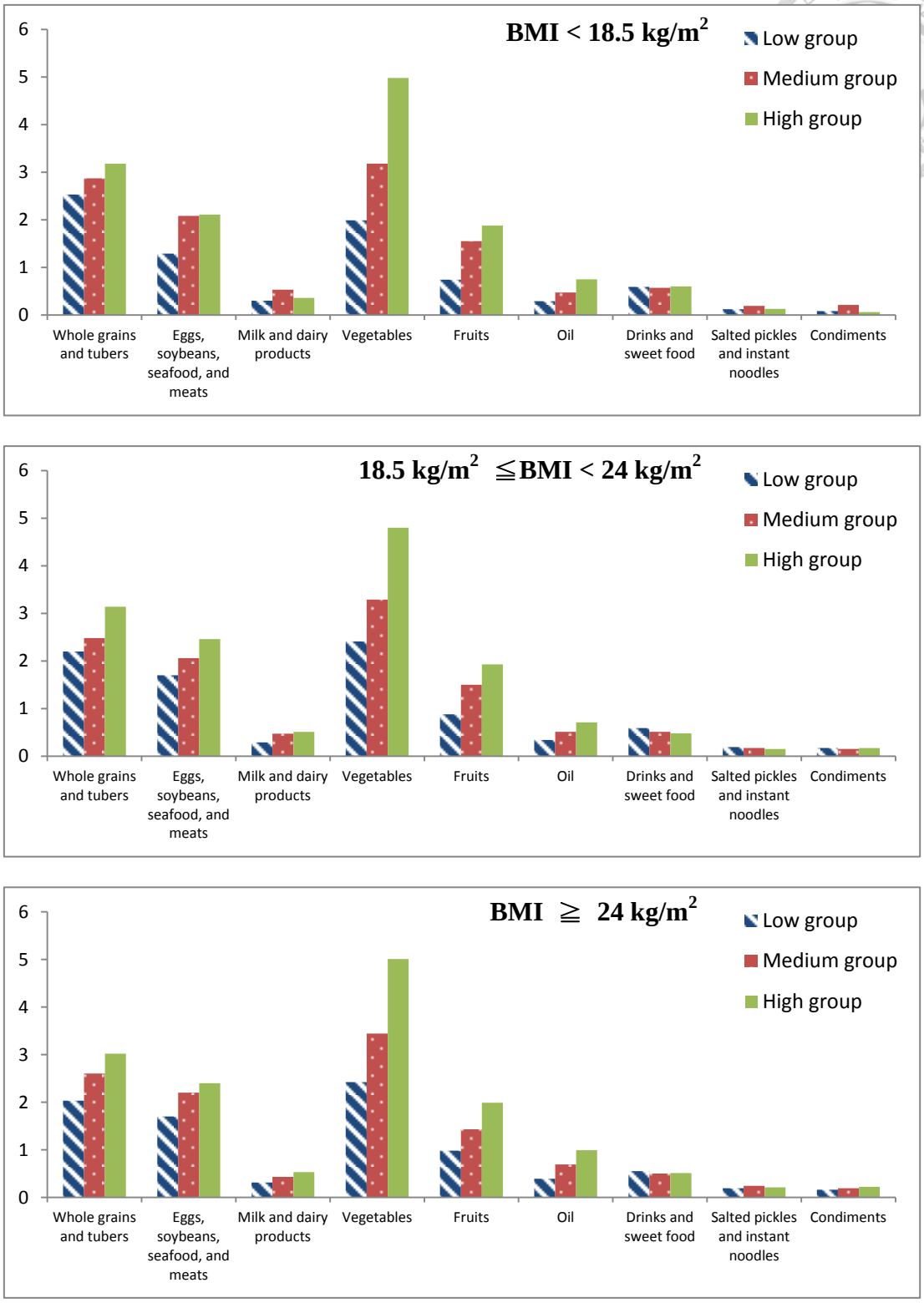


Figure 13. Daily number of servings on pattern 1 by the BMI groups by different food groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern; **BMI**, body mass index.

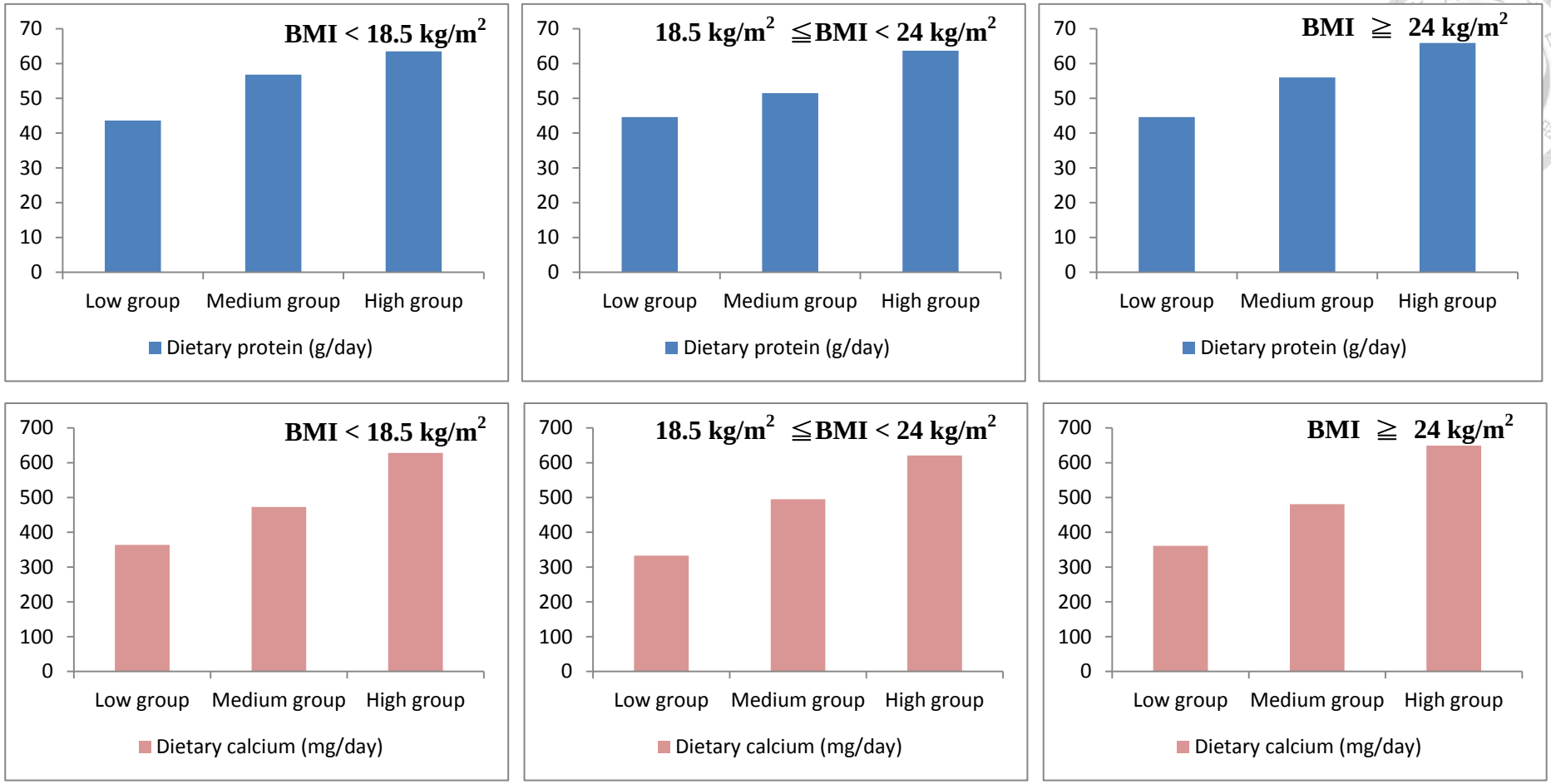


Figure 14. Dietary protein and calcium on pattern 1 by the BMI groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern; **BMI**, body mass index.

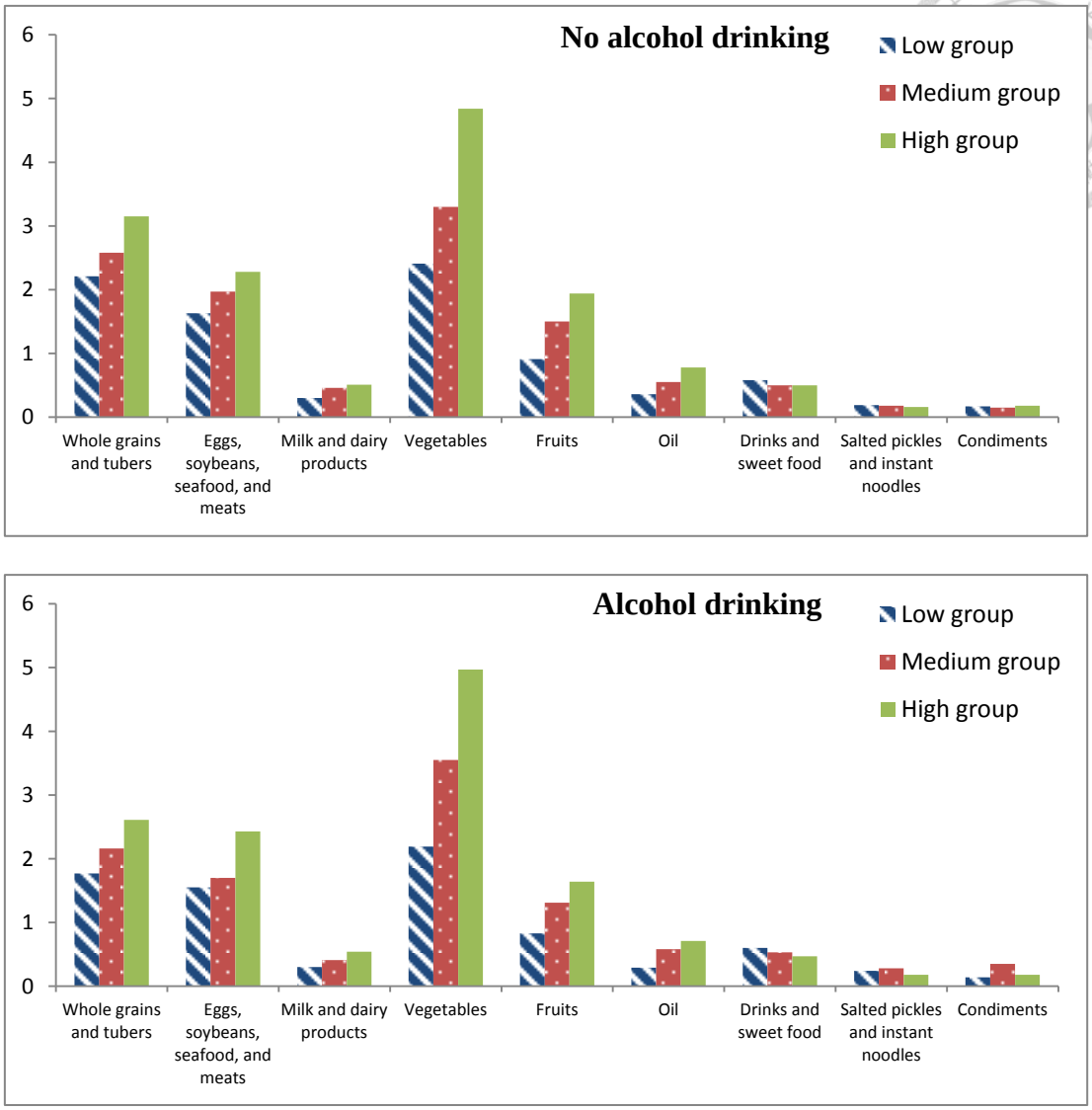


Figure 15. Daily number of servings on pattern 1 by the status of alcohol drinking by different food groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

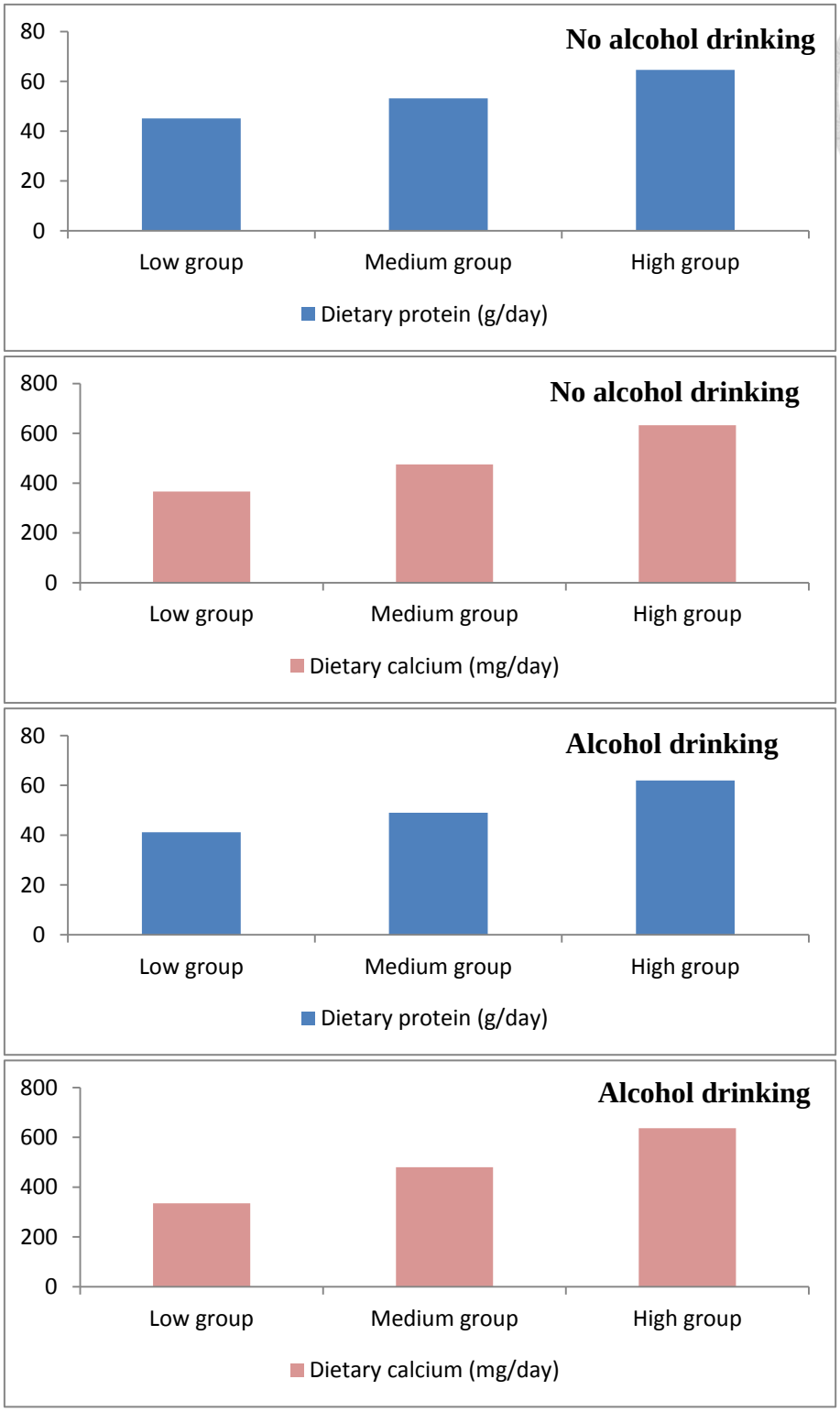


Figure 16. Dietary protein and calcium on pattern 1 by the status of alcohol drinking

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

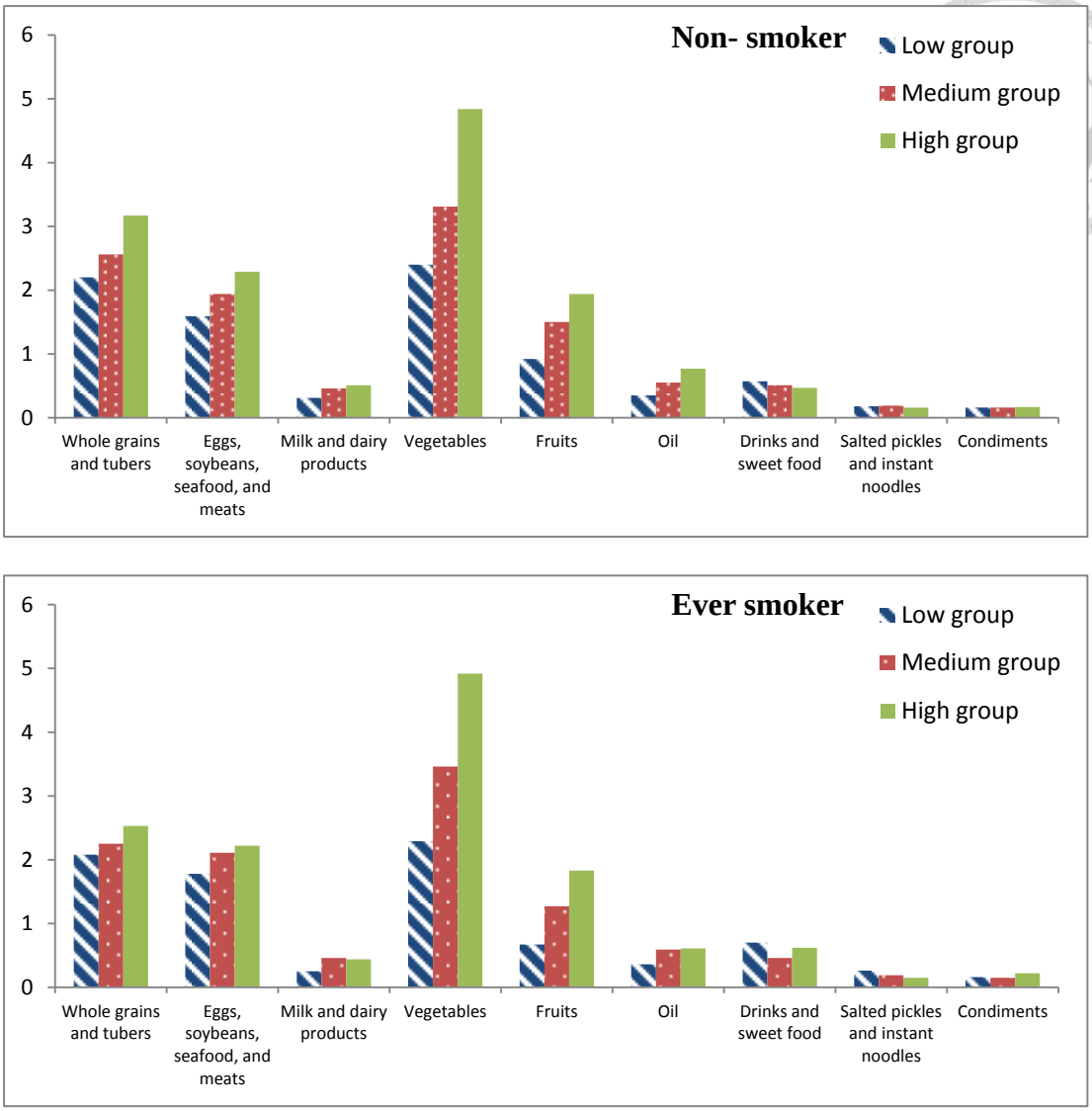


Figure 17. Daily number of servings on pattern 1 by the status of ever smoking by different food groups

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

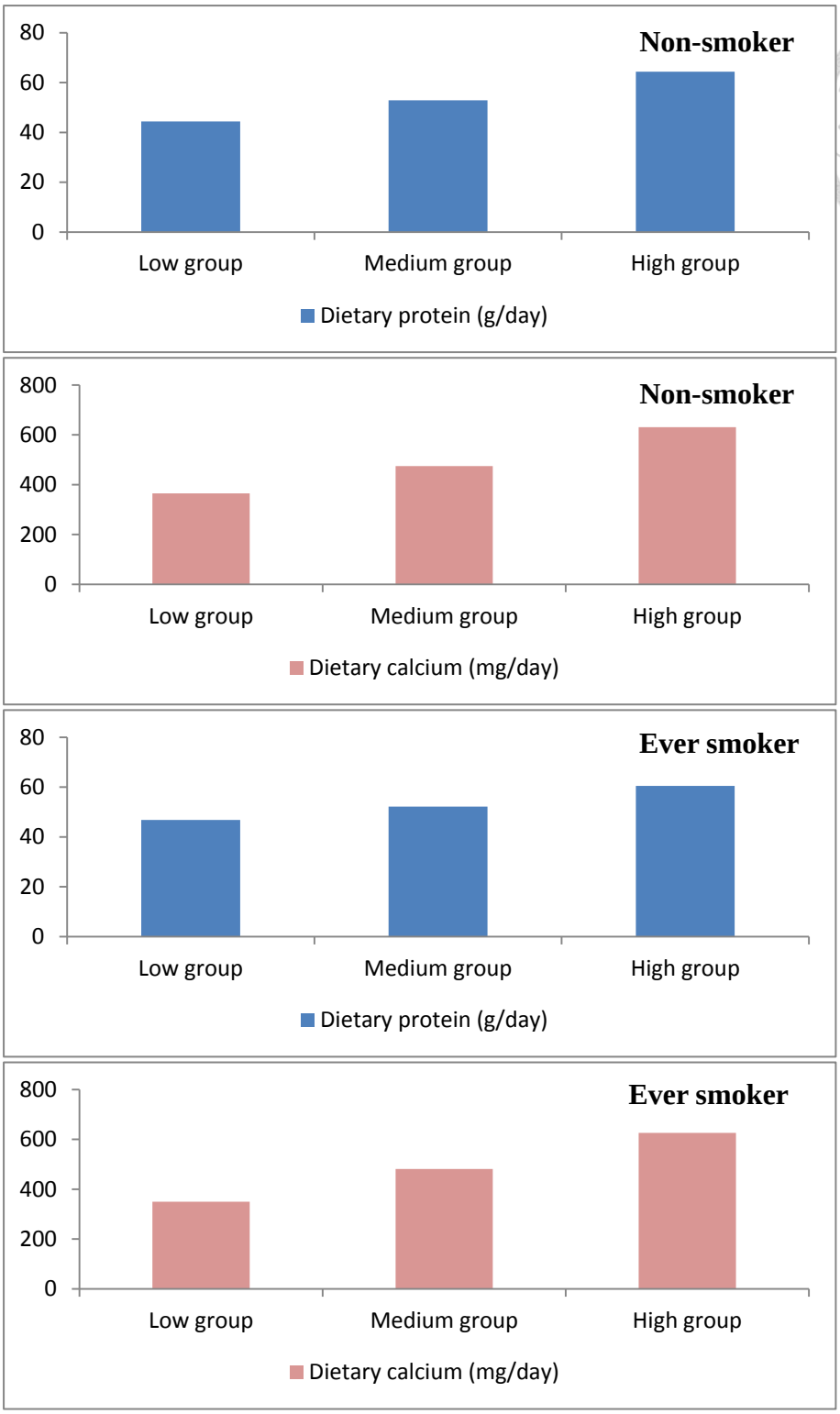


Figure 18. Dietary protein and calcium on pattern 1 by the status of ever smoking

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

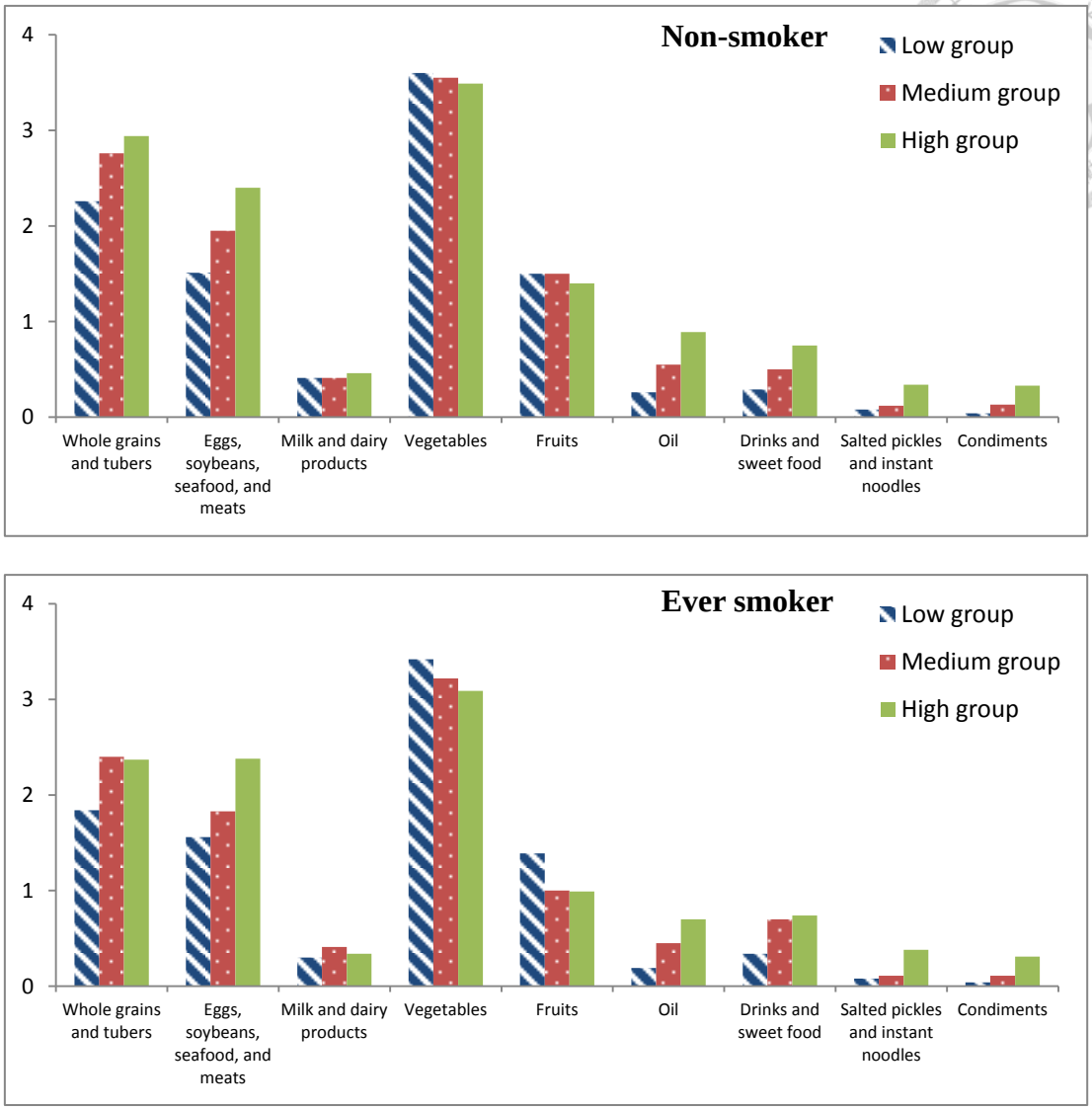


Figure 19. Daily number of servings on pattern 3 by the status of ever smoking by different food groups

Abbreviations: Pattern 3, Salted pickles and instant noodles dietary pattern.

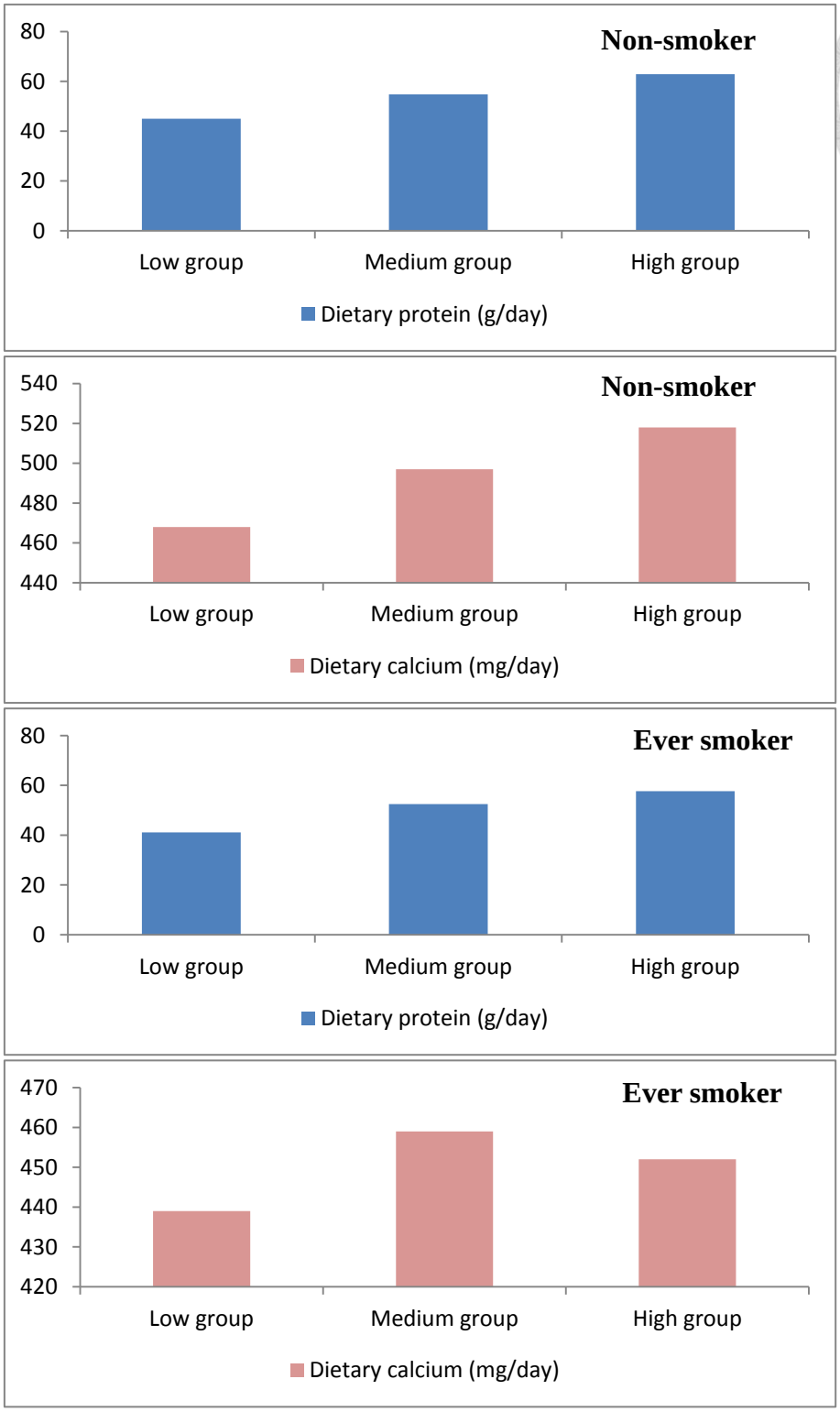


Figure 20. Dietary protein and calcium on pattern 3 by the status of ever smoking
Abbreviations: Pattern 3, Salted pickles and instant noodles dietary pattern.

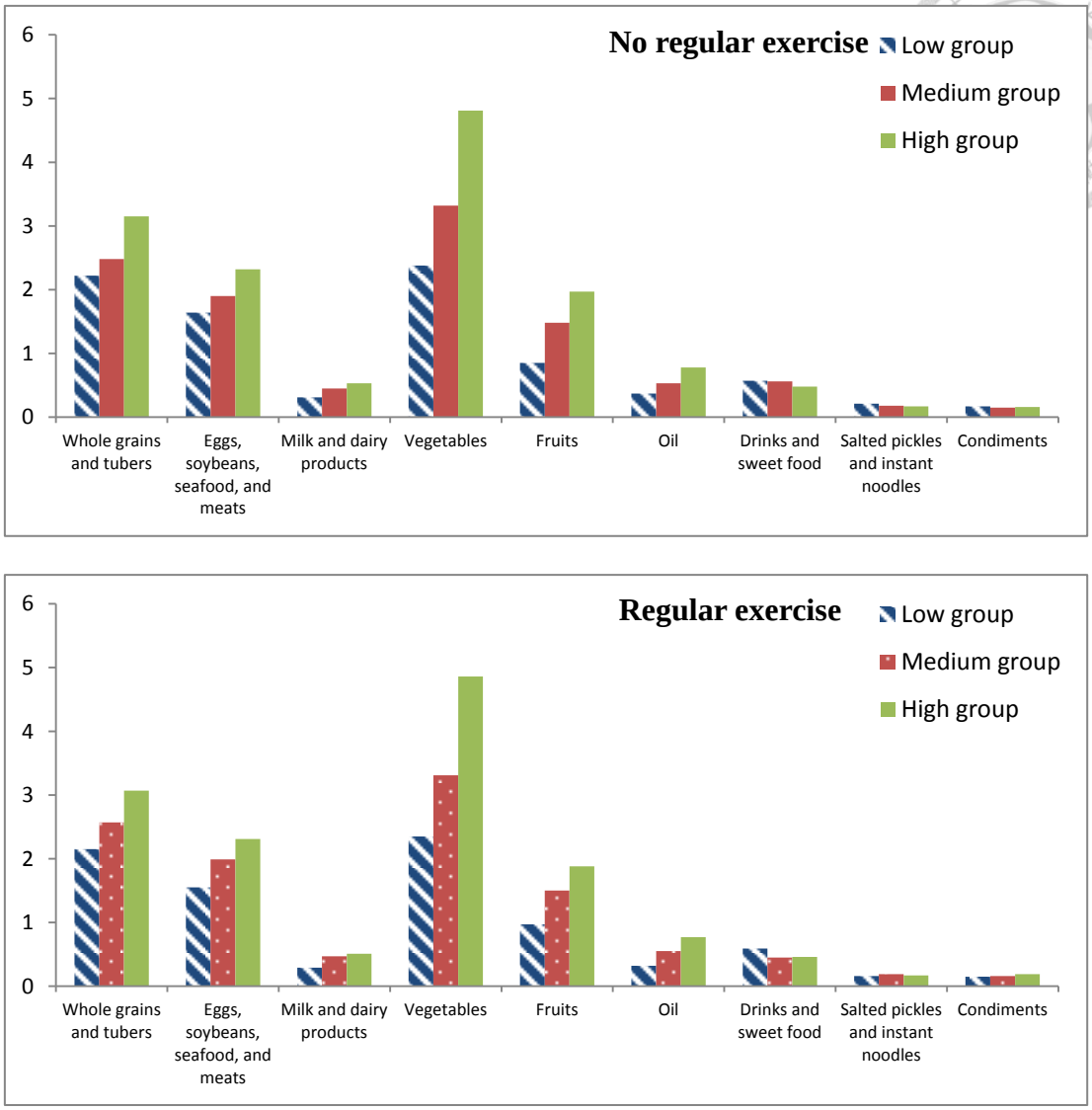


Figure 21. Daily number of servings on pattern 1 by regular exercise

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

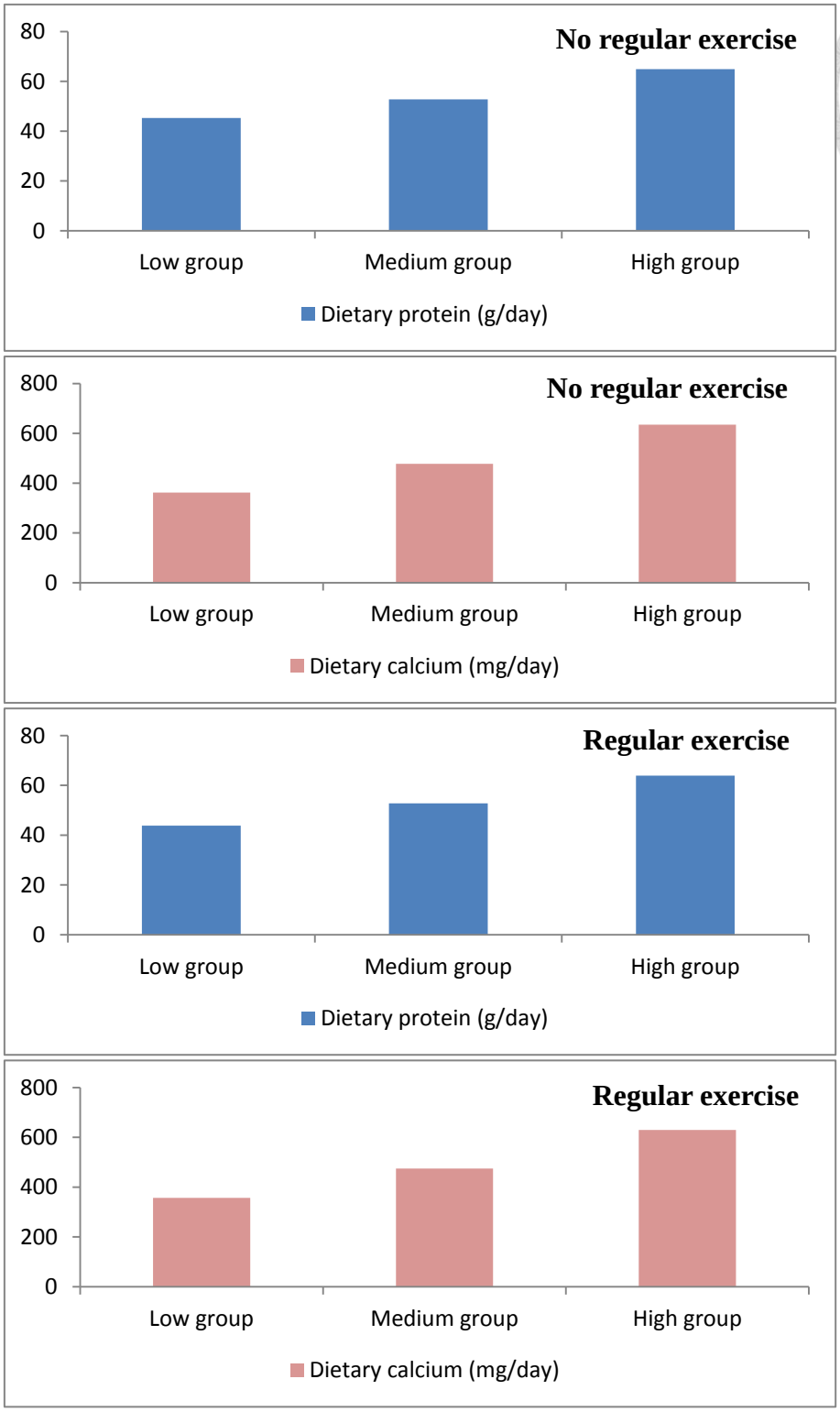


Figure 22. Dietary protein and calcium on pattern 1 by the regular exercise

Abbreviations: Pattern 1, vegetables and fruits dietary pattern.

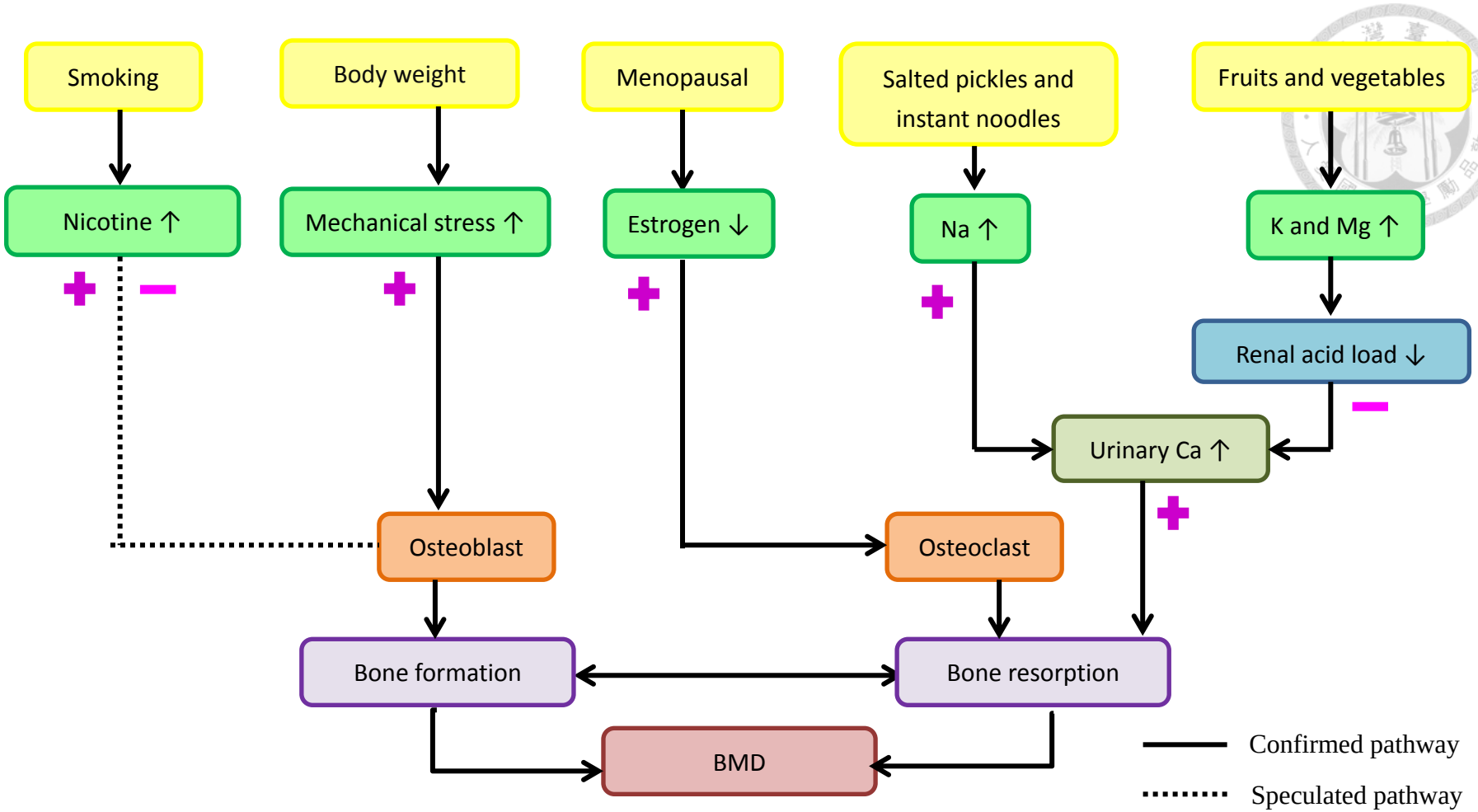


Figure 23. Postulated mechanism relating dietary patterns and bone mineral density

Reference: [55, 61, 65-70]

Abbreviations: K, potassium; **Mg**, magnesium; **Ca**, calcium.

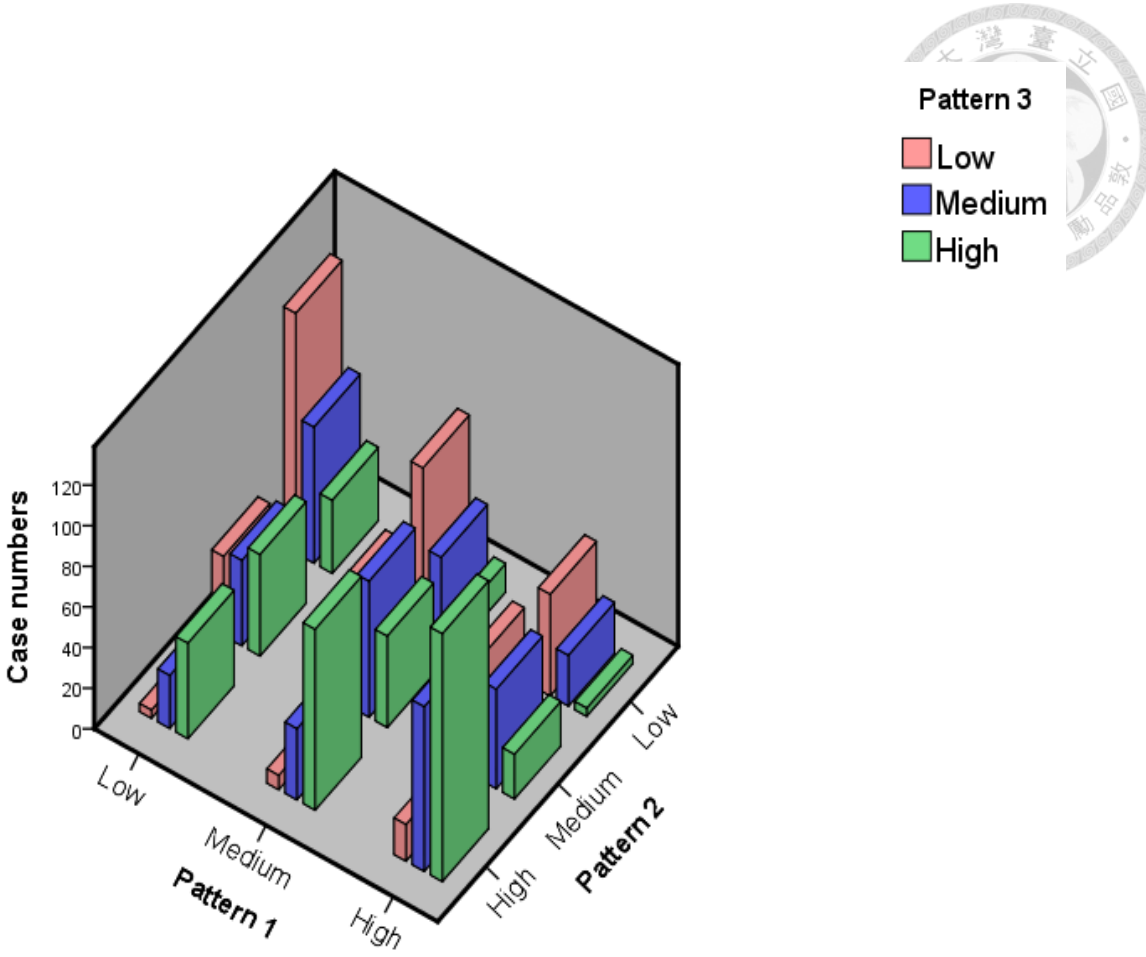


Figure 24. The distribution of different intake condition on different dietary pattern

Abbreviations: **pattern 1**, vegetables and fruits pattern; **pattern 2**, Meat, seafood, and oil pattern; **pattern 3**, Salted pickles and instant noodles pattern.

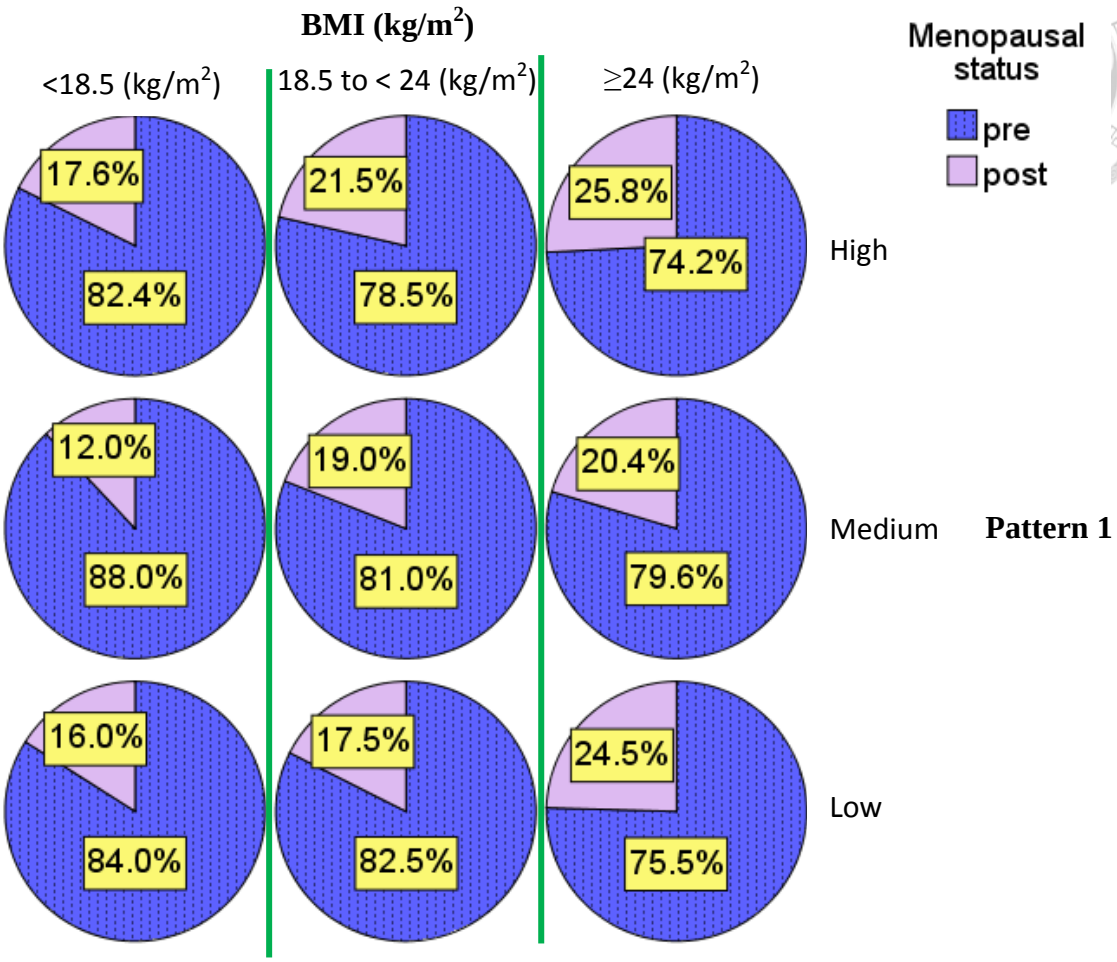


Figure 25. Menopausal status in different BMI groups on pattern 1

Abbreviations: **pattern 1**, vegetables and fruits pattern.

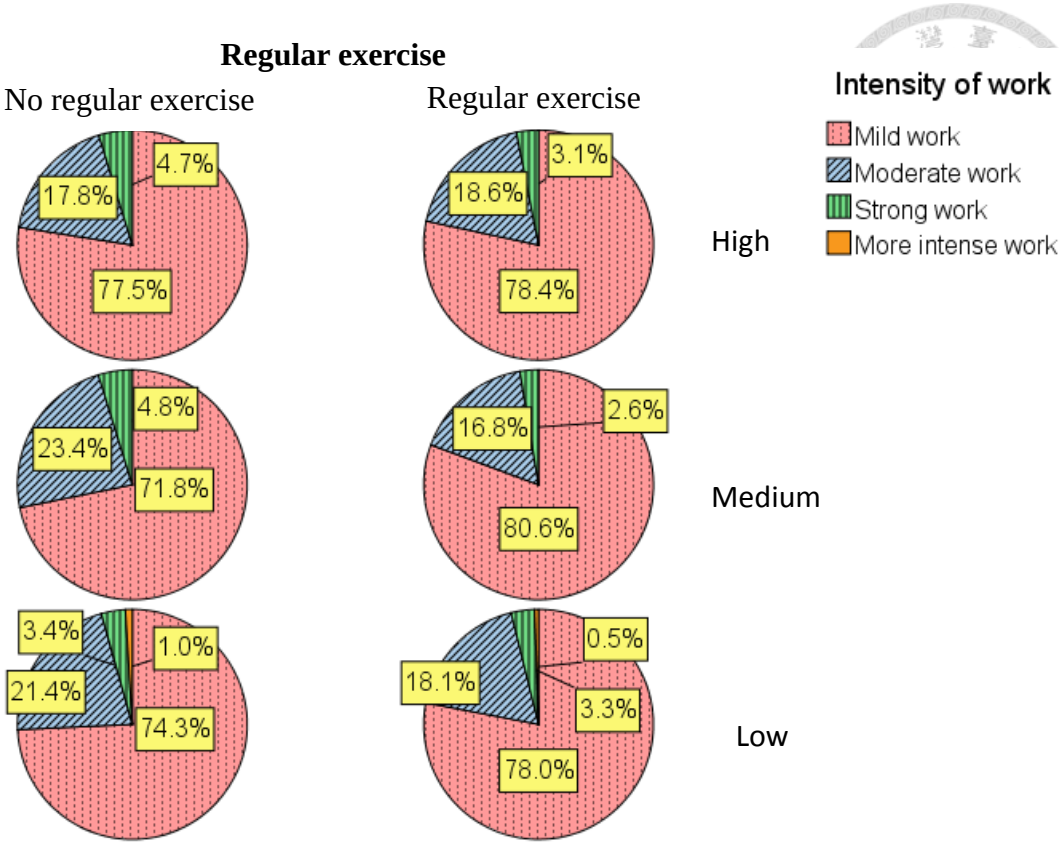


Figure 26. The status of intensity of work in different exercise groups on pattern 1

Abbreviations: **pattern 1**, vegetables and fruits pattern.

Table 1. Literature review on dietary pattern and bone mineral density

Study	Study type	Outcome (Y) / BMD Site & Machine	Diet (X)	Dietary assessment	Result	Adjustment	Limitations
Shin, S. et al. (2013)	• Cross-sectional • 95 boys and 101 girls • 12-15 y/o • Korean	• BMD • Lumbar spine (L1-L4) and femoral neck • DXA	Dietary patterns	• 6-days food records (5 weekdays, 1 weekend day)	• "Milk & cereal " pattern → In highest tertile of dietary pattern score High vs. the lowest BMD at lumbar spine (**AOR = 0.36**, p = 0.046, 95% CI = 0.14-0.93)	Age, BMI percentiles, sex, weight loss attempts, pubertal status, and regular exercise	• No causal relationship • No vitamin D data
Karamati, M. et al. (2012)	• Cross-sectional • 160 subjects • 50-85 y/o women • Menopausal • Iranian	• BMD • Lumbar spine (L1-L4) and left femoral neck • DXA	Dietary patterns	• Semi quantitative FFQ of 168 food items • Past 12 months	• 1st pattern (high consumption of high-fat dairy products, organ meats, red and processed meats and nonrefined cereals) → BMD below the median in lumbar spine (**AOR = 2.29**, 95% CI = 1.05-4.96, p = 0.04) • 2nd pattern (high in French fries,	Age, BMI, physical activity, smoking, education, fragility fracture history, history of hormone replacement therapy, supplement intake, age at menarche, antiresorptive drug and relative accuracy of energy appropriate	• No causal relationship • Not general population • Different socio-economic

Study	Study type	Outcome (Y) / BMD Site & Machine	Diet (X)	Dietary assessment	Result	Adjustment	Limitations
					mayonnaise, sweets, desserts and vegetable oil) → BMD below the median in femoral spine (**AOR = 2.83,** 95% CI = 1.31-6.09, $p < 0.01$)		
Fairweather-Tait, S. J. et al. (2011)	• Co-twin control study • 2,464 women • Menopausal • United Kingdom	• BMD • Total hip, femoral neck and lumbar spine • DXA	Dietary patterns	• 131-item food-frequency questionnaire	• Traditional English dietary pattern (high intakes of fried fish, fried potatoes, legumes, red and processed meats, savory pies and cruciferous vegetables) → negative association at the hip neck ($\beta = -0.055$, $p = 0.01$)	Age, age square, BMI, smoking, and physical activity	• No causal relationship
Okubo, H. et al. (2006)	• Cross-sectional • 291 subjects • 40-55 y/o • Premenopausal	• BMD • Forearm • DXA	Dietary patterns	• 16-page self-administered diet history questionnaire	• "Healthy" pattern (high intakes of green and dark yellow vegetable, mushrooms, fish, and	Age, BMI, grasping power, current smoking, fracture history, hormone	• No causal relationship

Study	Study type	Outcome (Y) / BMD Site & Machine	Diet (X)	Dietary assessment	Result	Adjustment	Limitations
	• Japanese women			• Previous month	fruit) → positively correlated with BMD (p = 0.048)	replacement therapy, age at menarche, parity, use of calcium and multivitamin supplements	
Tucker, K. L. et al. (2002)	• Cross-sectional • 907 subjects (345 men and 562 women) • 69-93 y/o • Framingham study	• BMD • Proximal right femur (femoral neck, trochanter and Ward's area) • Lunar dualphoton absorptiometer	Dietary patterns	• 126-item food-frequency questionnaire	• "Fruit, vegetables and cereal" group **Men:** Greater BMD than other group at hip (p = 0.05) • "Candy group" **Men:** Lower BMD than other group at the radius (p < 0.05) **Women:** Lower BMD than other group (p < 0.01)	Age, BMI, height, energy intake, physical activity score, smoking, vitamin D supplement use, calcium supplement use, and season	• No causal relationship

Abbreviations: BMD, bone mineral density; **AOR**, adjusted odds ratio; **CI**, confidence interval; **y/o**, years old; **BMI**, body mass index; **DXA**, dual-energy X-ray absorptiometry; **FFQ**, food frequency questionnaire.

Table 2. Characteristics of the study population

Variable	BMD (g/cm^2)		p value
	High	Low	
	n = 859	n = 429	
	Mean ± S.E.		
Age (year)[a]	45.6 ± 3.9	47.7 ± 4.6	**<0.0001**
BMI (kg/m^2)	22.8 ± 3.2	21.6 ± 2.9	**<0.0001**
ALP (IU)	56.6 ± 16.0	64.5 ± 18.5	**0.0007**
	n (%)		
Menopause			**<0.0001**
Post-	105 (12)	152 (35)	
Pre-	746 (87)	273 (64)	
Missing data	8 (1)	4 (1)	
Ever smoker			0.36
Yes	76 (9)	31 (7)	
No	765 (89)	382 (89)	
Missing data	18 (2)	16 (4)	
Alcohol drinking			0.46
Yes	52 (6)	30 (7)	
No	776 (90)	375 (87)	
Missing data	31 (4)	24 (6)	
Calcium supplement			0.33
Yes	444 (52)	234 (55)	
No	415 (48)	195 (45)	
Regular exercise[b]			
Yes	387 (45)	190 (44)	0.79
No	404 (47)	192 (45)	
Missing data	68 (8)	47 (11)	
Occupation-based socioeconomic status			
Retired or no job	22 (2)	17 (4)	0.41
Blue-collar worker	134 (15)	65 (15)	
White-collar employee	229 (27)	129 (30)	
Self-employed/academic profession	187 (22)	79 (18)	
Lifetime housewife	174 (21)	89 (21)	
Other jobs [c]	58 (7)	25 (6)	

Missing data	55 (6)	25 (6)

Abbreviations: **BMD**, bone mineral density; **S.E.**, standard error; **BMI**, body mass index, **ALP**, alkaline phosphatase.

Bold numbers indicate significant findings.

[a] P value was obtained from Mann-Whitney U tests for continuous variables.

[b] Regular exercise indicates at least 30 minutes at a time and 3 days per week.

[c] Other jobs included students and part-time job.

P value was obtained from t tests and chi-square tests for categorical variables.

Table 3. Factor loading matrix for each of the identified dietary pattern

Food or food group	Pattern1[a] Vegetables and fruits	Pattern 2[a] Meat, seafood, and oil	Pattern 3[a] Salted pickles and instant noodles
Dark-green vegetables	0.75		
Light-green vegetables	0.75		
Fruits	0.61		
Tubers	0.50		
Whole grains	0.45		
Meats		0.72	
Seafood		0.65	
Oil		0.60	
Eggs		0.50	
Salted pickles			0.66
Instant noodles			0.66
Condiments			0.62
Organ meats			0.54
Sugary beverages			
Jellies and honey			
Milk			
Dairy products			
Rice and noodle			
Bread			
Soybeans			
Explained variance (%)	11.1	10.1	9.2
Cumulative variance (%)	11.1	21.2	30.3

[a] Food items with ｜factor loading｜ of ≥0.4were kept in each pattern.

Table 4. Age and BMI adjusted spearman correlation coefficients between major factors

	BMD	Pattern 1	Pattern 2	Pattern 3	Total kilocalorie	ALP	Menopause status	Ever smoking	Alcohol drinking	Calcium supplement	Regular exercise	Occupation-based SES
BMD	1	0.02	0.01	0.03	0.06	-0.23***	-0.22***	0.02	0.01	0.02	0.02	0.04
Pattern 1		1	0.41***	0.06	0.55***	0.001	-0.002	-0.10**	-0.08**	0.04	0.03	0.08*
Pattern 2			1	0.55***	0.54***	-0.03	-0.04	-0.01	-0.04	0.02	0.03	-0.03
Pattern 3				1	0.42***	0.01	0.04	0.03	0.03	-0.01	0.0001	-0.02
Total kilocalorie					1	0.01	-0.02	-0.11**	-0.13***	0.02	0.003	0.06
ALP						1	0.21***	-0.0001	-0.06*	-0.04	-0.07*	-0.01
Menopause status							1	-0.01	-0.01	0.004	-0.02	0.05
Ever smoking								1	0.22***	0.003	-0.05	0.02
Alcohol drinking									1	-0.01	0.02	0.007
Calcium supplement										1	-0.01	0.02
Regular exercise											1	-0.004
Occupation-based SES												1

*p<0.05 **p<0.01 ***p<0.0001

Abbreviation: BMD, bone mineral density; **BMI**, body mass index; **ALP**, alkaline phosphatase; **Pattern 1**, vegetables and fruits dietary pattern; **Pattern 2**, meat, seafood, and oil dietary pattern; **Pattern 3**, salted pickles and instant noodles dietary pattern; **SES**, socioeconomic status.

Table 5. Characteristics of the study population according to different categories of the dietary pattern 1

Variable	Pattern 1: Vegetables and fruits			
	Low	Medium	High	p value
	Mean ± S.E.			
Age (year)[a]	46.1 ± 4.3	46.2 ± 4.3	46.6 ± 4.3	0.27
BMI (kg/m^2)	22.6 ± 3.4	22.3 ± 3.2	22.4 ± 3.0	0.42
ALP (IU)	59.5 ± 16.6	58.5 ± 16.9	60.0 ± 18.6	0.45
	n (%)			
Menopause				
Post-	81 (19)	81 (19)	95 (22)	0.41
Pre-	340 (79)	347 (80)	332 (77)	
Missing	8 (2)	2 (1)	2 (1)	
Ever smoking				
Yes	53 (12)	29 (7)	25 (6)	**<0.01**
No	362 (84)	395 (92)	390 (91)	
Missing	14 (4)	6 (1)	14 (3)	
Alcohol consumption				
Yes	34 (8)	23 (5)	25 (6)	0.20
No	368 (86)	392 (91)	391 (91)	
Missing	27 (6)	15 (4)	13 (3)	
Calcium supplement				
Yes	209 (49)	233 (54)	236 (55)	0.13
No	220 (51)	197 (46)	193 (45)	
Regular exercise[b]				
Yes	185 (43)	194 (45)	198 (46)	0.55
No	209 (49)	193 (45)	194 (45)	
Missing	35 (8)	43 (10)	37 (9)	
Occupation-based socioeconomic status				
Retired or no job	14 (3)	12 (3)	13 (3)	0.28
Blue-collar worker	81 (19)	62 (14)	56 (13)	
White-collar employee	119 (28)	128 (30)	111 (26)	
Self-employed/ academic profession	78 (18)	89 (21)	99 (23)	
Lifetime housewife	77 (18)	86 (20)	100 (23)	

Other jobs[c]	29 (7)	26 (6)	28 (7)
Missing data	31 (7)	27 (6)	22 (5)

Abbreviations: BMD, bone mineral density; **ALP**, alkaline phosphatase; **S.E.**, standard error; **BMI**, body mass index.

[a] P value was obtained from Mann-Whitney U tests for continuous variables.

[b] Regular exercise indicates least 30 minutes at time and 3 days per week.

[c] Other jobs included students and part-time job.

P value was obtained from t tests and chi-square tests for categorical variables.

Table 6. Characteristics of the study population according to different categories of the dietary pattern 2

Variable	Pattern 2: Meat, seafood, and oil			
	Low	Medium	High	p value
	Mean ± S.E.			
Age (year)[a]	47.0 ± 4.3	46.2 ± 4.3	45.7 ± 4.1	**<0.0001**
BMI (kg/m^2)	22.1 ± 2.9	22.2 ± 3.0	22.9 ± 3.5	**<0.01**
ALP (IU)	60.8 ± 17.3	57.7 ± 16.0	59.1 ± 18.2	**0.04**
	n (%)			
Menopause				
Post-	105 (24)	87 (20)	65 (15)	**<0.01**
Pre-	317 (74)	343 (80)	359 (84)	
Missing	7 (2)	0 (0)	5 (1)	
Ever smoking				
Yes	39 (9)	35 (8)	33 (8)	0.74
No	379 (88)	381 (89)	387 (90)	
Missing	11 (3)	14 (3)	9 (2)	
Alcohol consumption				
Yes	30 (7)	28 (7)	24 (6)	0.58
No	371 (87)	383 (89)	397 (93)	
Missing	28 (6)	19 (4)	8 (1)	
Calcium supplement				
Yes	225 (52)	229 (53)	224 (52)	0.95
No	204 (48)	201 (47)	205 (48)	
Regular exercise[b]				
Yes	192 (45)	182 (42)	203 (47)	0.43
No	196 (46)	206 (48)	194 (45)	
Missing	41 (9)	42 (10)	32 (8)	
Occupation-based socioeconomic status				
Retired or no job	19 (4)	14 (3)	6 (3)	**0.02**
Blue-collar worker	60 (14)	68 (16)	71 (16)	
White-collar employee	109 (25)	124 (29)	125 (29)	
Self-employed/ academic profession	77 (18)	88 (20)	101 (20)	
Lifetime housewife	92 (22)	89 (21)	82 (21)	

Other jobs[c]	39 (9)	27 (6)	17 (6)
Missing data	33 (8)	20 (5)	27 (5)

Abbreviations: BMD, bone mineral density; **ALP**, alkaline phosphatase; **S.E.**, standard error; **BMI**, body mass index.

[a] P value was obtained from Mann-Whitney U tests for continuous variables.

[b] Regular exercise indicates least 30 minutes at time and 3 days per week.

[c] Other jobs included students and part-time job.

P value was obtained from t tests and chi-square tests for categorical variables

Table 7. Characteristics of the study population according to different categories of the dietary pattern 3

Variable	Pattern 3: Salted pickles and instant noodles			
	Low	Medium	High	p value
	Mean ± S.E.			
Age (year)[a]	46.9 ± 4.3	46.6 ± 4.3	45.5 ± 4.2	**<0.0001**
BMI (kg/m^2)	22.2 ± 3.0	22.1 ± 3.0	22.9 ± 3.5	**<0.0001**
ALP (IU)	59.1 ± 16.7	59.8 ± 17.7	59.4 ± 17.9	0.96
	n (%)			
Menopause				
Post-	98 (23)	76 (18)	83 (19)	0.17
Pre-	329 (76)	349 (81)	341 (80)	
Missing	2 (1)	5 (1)	5 (1)	
Ever smoking				
Yes	30 (7)	32 (7)	45 (11)	0.11
No	388 (90)	390 (91)	369 (86)	
Missing	11 (3)	8 (2)	15 (3)	
Alcohol consumption				
Yes	29 (7)	16 (4)	37 (9)	**0.01**
No	375 (87)	399 (93)	377 (88)	
Missing	25 (6)	15 (3)	15 (3)	
Calcium supplement				
Yes	231 (54)	227 (53)	220 (51)	0.75
No	198 (46)	203 (47)	209 (49)	
Regular exercise[b]				
Yes	190 (44)	202 (47)	185 (43)	0.43
No	199 (46)	189 (44)	208 (48)	
Missing	40 (10)	39 (9)	36 (9)	
Occupation-based socioeconomic status				
Retired or no job	20 (5)	13 (3)	6 (1)	0.06
Blue-collar worker	50 (12)	72 (17)	77 (18)	
White-collar employee	129 (30)	113 (26)	116 (27)	
Self-employed/ academic profession	86 (20)	84 (20)	96 (23)	
Lifetime housewife	86 (20)	97 (23)	80 (19)	

Other jobs[c]	28 (6)	28 (6)	27 (6)
Missing data	30 (7)	23 (5)	27 (6)

Abbreviations: BMD, bone mineral density; **ALP**, alkaline phosphatase; **S.E.**, standard error; **BMI**, body mass index.

[a] P value was obtained from Mann-Whitney U tests for continuous variables.

[b] Regular exercise indicates least 30 minutes at time and 3 days per week.

[c] Other jobs included students and part-time jobs.

P value was obtained from t tests and chi-square tests for categorical variables.

Table 8. Association between dietary pattern score (tertile) and BMD (high vs. low)

Pattern	High/Low	Crude OR	AOR[a]	AOR[b]
1. Vegetables and fruits				
Low (ref)	272/157	1.00	1.00	1.00
Medium	307/123	**0.69 (0.52-0.93)**	**0.62 (0.45-0.84)**	**0.66 (0.46-0.94)**
High	280/149	0.92 (0.70-1.22)	0.81 (0.60-1.10)	0.76 (0.54-1.07)
p for trend		0.71	0.26	0.17
2. Meat, seafood, and oil				
Low (ref)	273/156	1.00	1.00	1.00
Medium	283/147	0.91 (0.69-1.20)	1.01 (0.75-1.37)	1.04 (0.73-1.47)
High	303/126	**0.73 (0.55-0.97)**	0.97 (0.71-1.32)	1.03 (0.72-1.46)
p for trend		**0.03**	0.82	0.90
3. Salted pickles and instant noodles				
Low (ref)	277/152	1.00	1.00	1.00
Medium	279/151	0.99 (0.75-1.31)	1.05 (0.78-1.42)	0.99 (0.70-1.39)
High	303/126	0.76 (0.57-1.01)	0.95 (0.70-1.30)	0.86 (0.60-1.23)
p for trend		**0.04**	0.71	0.38

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference group; **SES**, socioeconomic status.

[a]All models were adjusted for age (years), BMI (kg/m^2), and menopausal status (yes/no).

[b]All models were adjusted for variables above plus alcohol drinking (yes/no), ever smoking status (yes/no), calcium supplement (yes/no), regular exercise (≥ 30 minutes/times and ≥ 3 days/week / < 30 minutes/times and < 3 days/week), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/self-employed and academic profession/lifetime housewife/other jobs).

Table 9. Association between dietary pattern and BMD by menopausal status

BMD group	Premenopausal (n = 1,019)		Postmenopausal (n = 257)	
	High/Low	AOR[a]	High/Low	AOR[a] (95% CI)
	746/273	1.00	105/152	**2.71 (1.76-4.19)**

Pattern	Premenopausal (n = 1,019)		Postmenopausal (n = 257)		*p* for interaction
	H/L	AOR[a] (95% CI)	H/L	AOR[a] (95% CI)	
1. Vegetables and fruits					
Low (ref)	233/107	1.00	33/48	1.00	0.06
Medium	276/71	**0.58 (0.39-0.86)**	30/51	0.81 (0.33-1.97)	
High	237/95	0.80 (0.55-1.18)	42/53	0.48 (0.20-1.15)	
p for trend		0.35		0.08	
2. Meat, seafood, and oil					
Low (ref)	226/91	1.00	42/63	1.00	0.17
Medium	250/93	0.96 (0.64-1.43)	33/54	1.21 (0.55-2.65)	
High	270/89	1.06 (0.71-1.57)	30/35	0.87 (0.37-2.05)	
p for trend		0.75		0.79	
3. Salted pickles and instant noodles					
Low (ref)	236/93	1.00	40/58	1.00	0.22
Medium	245/104	1.07 (0.73-1.57)	32/44	0.68 (0.30-1.55)	
High	265/76	0.81 (0.54-1.22)	33/50	1.13 (0.49-2.60)	
p for trend		0.24		0.65	

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference group; **H/L**, High BMD group / Low BMD group; **SES**, socioeconomic status.

[a]All models were adjusted for age (years), BMI(kg/m^2), alcohol drinking (yes/no), ever smoking status (yes/no), calcium supplement (yes/no), regular exercise (≥ 30 minutes/times and ≥ 3 days/week / < 30 minutes/times and < 3 days/week), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/self-employed and academic profession/lifetime housewife/other jobs)..

Table 10. Association between dietary pattern and BMD by BMI groups

BMD group	BMI < 18.5 kg/m^2 (n = 67)		18.5 ≦ BMI < 24 kg/m^2 (n = 919)		BMI ≧ 24 kg/m^2 (n = 301)	
	High/Low	AOR[a] (95% CI)	High/Low	AOR[a]	High/Low	AOR[a] (95% CI)
	30/37	**2.98 (1.64-5.42)**	593/326	1.00	235/66	**0.38 (0.26-0.56)**

Pattern	BMI < 18.5 kg/m^2 (n = 67)		18.5 ≦ BMI < 24 kg/m^2 (n = 919)		BMI ≧ 24 kg/m^2 (n = 301)		*p* for interaction
	H/L	AOR[a] (95% CI)	H/L	AOR[a] (95% CI)	H/L	AOR[a] (95% CI)	
1. Vegetables and fruits							
Low (ref)	8/17	1.00	173/115	1.00	90/25	1.00	0.06
Medium	16/9	0.15 (0.02-1.33)	218/94	**0.62 (0.41-0.93)**	73/20	1.19 (0.52-2.74)	
High	6/11	1.32 (0.16-11.04)	202/117	0.71 (0.48-1.07)	72/21	1.19 (0.52-2.74)	
p for trend		0.69		0.15		0.70	
2. Meat, seafood, and oil							
Low (ref)	13/16	1.00	196/119	1.00	63/21	1.00	0.58
Medium	9/10	1.05 (0.16-6.74)	199/115	1.06 (0.71-1.58)	75/22	1.12 (0.46-2.73)	
High	8/11	2.97 (0.46-19.13)	198/92	0.97 (0.64-1.47)	97/23	1.23 (0.52-2.90)	
p for trend		0.26		0.86			
3. Salted pickles and instant noodles							
Low (ref)	11/13	1.00	199/114	1.00	67/25	1.00	0.14
Medium	12/16	2.28 (0.33-15.95)	202/114	0.99 (0.67-1.47)	64/21	0.96 (0.43-2.17)	
High	12/16	0.92 (0.11-7.81)	192/98	0.95 (0.63-1.44)	104/20	0.56 (0.25-1.26)	

p for trend	0.87	0.80	**0.13**

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference group; **H/L**, High BMD group / Low BMD group; **SES**, socioeconomic status.

[a]All models were adjusted for age (years), menopausal status (yes/no), alcohol drinking (yes/no), ever smoking status (yes/no), calcium supplement (yes/no), regular exercise (≥ 30 minutes/times and ≥ 3 days/week / < 30 minutes/times and < 3 days/week), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/self-employed and academic profession/lifetime housewife/other jobs).

Table 11. Association between dietary pattern and BMD by the status of alcohol drinking

BMD group	No alcohol drinking (n = 1151)		Alcohol drinking (n = 82)	
	High/Low	AOR[a]	High/Low	AOR[a] (95% CI)
	776/375	1.00	52/30	1.35 (0.75-2.41)

Pattern	No alcohol drinking (n = 1151)		Alcohol drinking (n = 82)		*p* for interaction
	H/L	AOR[a] (95% CI)	H/L	AOR[a] (95% CI)	
1. Vegetables and fruits					
Low (ref)	237/131	1.00	19/15	1.00	0.65
Medium	281/111	**0.64 (0.44-0.92)**	17/16	0.90 (0.19-4.21)	
High	258/133	0.73 (0.51-1.05)	16/9	1.16 (0.29-4.62)	
p for trend		0.14		0.85	
2. Meat, seafood, and oil					
Low (ref)	241/130	1.00	18/12	1.00	0.80
Medium	255/128	1.03 (0.72-1.48)	17/11	1.94 (0.44-8.61)	
High	280/117	1.02 (0.70-1.47)	17/7	1.16 (0.26-5.16)	
p for trend		0.95		0.81	
3. Salted pickles and instant noodles					
Low (ref)	245/130	1.00	20/9	1.00	0.11
Medium	259/140	0.98 (0.69-1.34)	11/5	1.54 (0.28-8.42)	
High	272/105	0.80 (0.55-1.16)	21/16	2.63 (0.62-11.11)	
p for trend		0.21		0.19	

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference

group; **H/L**, High BMD group / Low BMD group, **SES**, socioeconomic status.

[a]All models were adjusted for age (years), BMI(kg/m^2), menopausal status (yes/no), ever smoking status (yes/no), calcium supplement (yes/no), regular exercise (≥ 30 minutes/times and ≥ 3 days/week / < 30 minutes/times and < 3 days/week), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/self-employed and academic profession/lifetime housewife/other jobs).

Table 12. Association between dietary pattern and BMD by the status of ever smoking

BMD group	Never-smoking (n = 1,147)		Ever-smoking (n = 107)	
	High/Low	AOR[a]	High/Low	AOR[a] (95% CI)
	765/382	1.00	76/31	0.79 (0.46-1.35)

Pattern	Never-smoking (n = 1,147)		Ever-smoking (n = 107)		*p* for interaction
	H/L	AOR[a] (95% CI)	H/L	AOR[a] (95% CI)	
1. Vegetables and fruits					
Low (ref)	230/132	1.00	36/17	1.00	0.26
Medium	278/117	**0.67 (0.47-0.97)**	24/5	0.38 (0.09-1.63)	
High	257/133	0.74 (0.51-1.06)	16/9	1.48 (0.42-5.27)	
p for trend		0.14		0.67	
2. Meat, seafood, and oil					
Low (ref)	244/138	1.00	24/15	1.00	0.67
Medium	248/133	1.03 (0.72-1.48)	27/8	1.93 (0.43-8.62)	
High	273/114	1.00 (0.69-1.44)	25/8	1.54 (0.36-6.65)	
p for trend		0.97		0.61	
3. Salted pickles and instant noodles					
Low (ref)	248/140	1.00	24/6	1.00	**0.03**
Medium	256/134	0.88 (0.62-1.26)	18/14	**8.74 (1.43-53.43)**	
High	261/108	0.82 (0.56-1.18)	34/11	3.53 (0.66-18.98)	
p for trend		0.30		0.53	

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference

group; **H/L**, High BMD group / Low BMD group, **SES**, socioeconomic status.

[a]All models were adjusted for age (years), BMI(kg/m^2), menopausal status (yes/no), alcohol drinking (yes/no), calcium supplement (yes/no), regular exercise (≥ 30 minutes/times and ≥ 3 days/week / < 30 minutes/times and < 3 days/week), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/ self-employed and academic profession/lifetime housewife/other jobs).

Table 13. Association between dietary pattern and BMD by regular exercise

BMD group	No regular exercise (n = 596)		Regular exercise[a] (n = 577)	
	High/Low	AOR[b]	High/Low	AOR[b] (95% CI)
	404/192	1.00	387/190	1.05 (0.79-1.40)

Pattern	No regular exercise (n = 596)		Regular exercise (n = 577)		*p* for interaction
	H/L	AOR[b] (95% CI)	H/L	AOR[b] (95% CI)	
1. Vegetables and fruits					
Low (ref)	132/77	1.00	122/63	1.00	**0.02**
Medium	142/52	**0.43 (0.26-0.71)**	133/61	0.97 (0.58-1.60)	
High	130/64	0.63 (0.39-1.02)	132/66	0.92 (0.55-1.54)	
p for trend		0.09		0.76	
2. Meat, seafood, and oil					
Low (ref)	123/78	1.00	123/69	1.00	0.56
Medium	143/63	1.03 (0.63-1.68)	122/60	1.01 (0.61-1.67)	
High	138/56	1.11 (0.66-1.85)	142/61	0.91 (0.55-1.51)	
p for trend		0.69		0.70	
3. Salted pickles and instant noodles					
Low (ref)	135/64	1.00	118/72	1.00	0.07
Medium	122/67	1.35 (0.83-2.20)	137/65	0.74 (0.46-1.20)	
High	147/61	1.03 (0.62-1.71)	132/53	0.70 (0.42-1.17)	
p for trend		0.91		0.22	

Abbreviations: **BMD**, bone mineral density; **AOR**, adjusted odds ratio; **BMI**, body mass index; **CI**, confidence interval; **ref**, reference

group; **H/L**, High BMD group / Low BMD group, **SES**, socioeconomic status..

[a] Regular exercise is defined as 3 times per week and each time last for 30 minutes.

[b]All models were adjusted for age (years), BMI(kg/m^2), menopausal status (yes/no), alcohol drinking (yes/no), ever smoking status (yes/no), calcium supplement (yes/no), and alkaline phosphatase (IU), occupation-based SES (retired or no job/blue-collar worker/white-collar employee/ self-employed and academic profession/lifetime housewife/other jobs).

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Appendix

Appendix 1. MJ semi-quantitative food frequency questionnaire

健康問卷填寫說明

本問卷資料是醫師為您解說健康檢查判讀時之重要依據，請務必詳實回答。若不據實填寫，可能造成醫師診斷結果不完全，而影響您疾病治療先機。

填寫方式

1. 請依您本身狀況選擇合適的答案，並將前方「 ○ 」 塗滿。
2. 請使用2B、藍色或黑色原子筆填寫。
3. 填選示範(請輕輕塗寫即可)：
   (a)正確劃法　　(b)錯誤劃法
   ●　　太　高→ ⊖　　太　低→ ⊖　　打勾或劃圈→ ✓ ○
   太小未塗滿→ ⊙ ⊖　　劃過框→ ⊖

選項定義

1. 不會：表示從未或極少發生　2. 偶爾：表示每月發生1～3次　3. 經常：表示每週發生1～3次
4. 每日：表示每天均有發生

飲食評估填寫說明

1. 目的：
   藉由健康問卷中飲食相關問題，依受檢者填寫的食物攝取量與攝取頻率、個人工作量、運動量評估日常各類食物與營養素攝取情形，並以『飲食金字塔』為基礎，為您提供日常飲食、生活習慣、運動的建議，真正達到健康促進的目的。評估內容包括各類食物(含六大類食品：奶類、肉魚豆蛋類、五穀根莖類、蔬菜類、水果類及油脂類)、營養素(含蛋白質、脂肪、醣類及鈣質、鐵質、維生素、B1、B2、C、纖維素等)、單糖類、膽固醇、鹽分、酒精的攝取量。

2. 飲食評估例子：

   肉類(含豬、雞、鴨、牛、羊)吃多少？(1份相當於豬(牛)肉排1片〈約手掌大小厚1公分〉；雞小腿1支；其他瘦肉(肉片)2兩≒4湯匙)

   ○ 不吃或每週少於1份　○ 每週吃1-3份　○ 每週吃4-6份　○ 每天吃1份　● 每天吃2份或以上

   ※假設三餐肉類食用情形如下：
   早餐：瘦肉2湯匙　(等於肉類0.5份)
   午餐：肉絲2兩　(等於肉類1份)
   　　雞小腿1支　(等於肉類1份)
   晚餐：肉絲2湯匙　(等於肉類0.5份)
   →合計一天肉類總量等於3份，塗選 “ ○ 每天吃2份或以上 ”

3. 量具：


湯匙(15g)


直徑16cm-家用碗


240c.c.杯子

保管方式

健康問卷應保持乾淨、乾燥，並防止受潮。

注意事項

填寫時有任何疑問，請向美兆診所護理人員或營養師詢問。
台北美兆診所：(02)2567-2233　桃園美兆診所：(03)352-8899
台中美兆診所：(04)2359-8686　高雄美兆診所：(07)815-0033

　MJ2008.01-0711TW

美兆診所

美兆自動化健檢 MJ AMHTS

NO.

（健康問卷 01）

編碼	⓪①②③④⑤⑥⑦⑧⑨ ⓪①②③④⑤⑥⑦⑧⑨ ⓪①②③④⑤⑥⑦⑧⑨

姓　　名		性 別	□男 □女	序 號	
E-Mail帳號					

<請由此開始作答，正確劃記方式如 ●，以2B、藍或黑色原子筆輕輕塗寫即可>

健檢確認事項

1.健檢當日標準餐選擇：　○ 葷食　○ 素食

2.您的血型是：　○ A　○ B　○ O　○ AB　○ 不知道

基本資料

1.職業：　○ 學生(高中職、國中小)　○ 學生(專科、大學以上)　○ 專門職(律師、老師、會計師、護士、醫師)
○ 技術職(工程師、建築師、程式師)　○ 管理職(政府及民營單位課長以上主管)　○ 銷售職(業務、店員)
○ 服務職(餐飲、旅遊、美髮、司機)　○ 事務職(政府及民營單位文書、會計、行政事務)
○ 勞務職(勞力工作者)　○ 自營者(農林漁牧)　○ 自營者(10人以下工商企業)
○ 自營者(10人以上工商企業)　○ 藝術工作者　○ 家庭主婦（無兼職）
○ 兼職（無專職工作者）　○ 退休　○ 待業中
○ 軍人　○ 其他：_____

2.教育程度：○ 不識字　○ 小學　○ 國中　○ 高中(職)　○ 專科　○ 大學　○ 研究所以上

3.婚姻狀況：○ 未婚　○ 有偶　○ 離婚　○ 喪偶

4.您幾歲時生產第一胎?〈限女性回答〉○ 19歲以下　○ 20-24歲　○ 25-29歲　○ 30-34歲　○ 35歲以上　○ 無

5.您是否曾哺乳?〈曾生育者回答〉　○ 否　○ 是

6.家庭年收所得約：　○ 無　○ 40萬以下　○ 41-80萬　○ 81-120萬　○ 121-160萬　○ 161-200萬　○ 201萬以上

7.您的慣用手是：　○ 左手 ○ 右手

〈第二次或二以上至美兆做健康檢查者，可直接跳答第15題〉

8.您是雙胞胎嗎?　○ 否　○ 是

9.您祖父是..... ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

10.您祖母是〈填寫9、10題者可跳答第12題〉 ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

11.您父親是..... ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

12.您外祖父是..... ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

13.您外祖母是〈填寫12、13題者可跳答第15題〉 ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

14.您母親是..... ○ 其他省籍 ○ 閩南 ○ 客家 ○ 原住民 ○ 外國籍

生活習慣

15.您抽菸嗎?〈選擇"不抽"者，請跳答第18題〉 ○ 不抽　○ 不抽，但經常吸二手菸　○ 以前抽，現已戒菸
○ 偶爾抽　○ 每天抽

16.您抽菸已抽幾年了?〈戒菸者依過去情形回答〉 ○ 未滿一年　○ 一年至三年　○ 三年至五年　○ 五年至十年　○ 十年以上

17.您平均每天抽多少菸?〈戒菸者依過去情形回答〉 ○ 半包以內　○ 半包至一包　○ 一包以上

18.您喝酒嗎?〈選擇"不喝或每週少於1次"者，請跳答第22題〉
○ 不喝或每週少於一次　○ 以前喝，現已戒酒　○ 每週1-2次　○ 每週3-4次　○ 每天喝

19.您喝酒已喝幾年了?〈戒酒者依過去情形回答〉 ○ 未滿一年　○ 一年至三年　○ 三年至五年 ○ 五年至十年 ○ 十年以上

20.您平時飲酒會選擇何種酒類?〈戒酒者依過去情形回答，可複選〉
○ 酒精濃度小於15%(如啤酒、玫瑰紅酒、葡萄酒、香檳)　○ 酒精濃度15-30%(如紹興酒、米酒、花雕酒、烏梅酒)
○ 酒精濃度30-45%(如白蘭地、威士忌、蘭姆酒、玫瑰露酒、長春酒、龍鳳酒、蔘茸酒)
○ 酒精濃度大於45%(如大麴酒、高粱酒、五加皮酒、茅台酒、伏特加)

21.您每次喝酒的習慣爲何?〈戒酒者依過去情形回答〉(１杯相當於150c.c.或一紙杯量)
○ 少於半杯　○ 半杯到一杯　○ 二杯到三杯　○ 四杯或以上

【第一面】【請翻至第二面繼續作答】

美兆診所

美兆自動化健檢 MJ AMHTS

(健康問卷 02)

22.您是否嚼檳榔？

○ 不嚼 ○ 以前嚼，現已戒 ○ 每週1~3次 ○ 每週4~5次 ○ 每天嚼

23.您日常的工作活動強度爲何?

○ 大部份時間坐著的工作： 研究、辦事務、管理、家庭主婦(沒有帶幼兒)、教職員、學生 (體育系除外)、司機等

○ 坐、走頻繁重複的工作： 製造業、營業販賣、服務業、家庭主婦(有帶幼兒)、醫生、護士、看護婦、淡季農漁業等

○ 大部份站著、走動的工作：建築業、學生 (體育系)、繁忙期的漁農業等

○ 須用全身肌肉的工作：職業運動選手、鑄鐵業、搬運工作等

24.您的工作場所有否影響健康的危害事項? ○ 粉塵(如石棉) ○ 化學物質(如有機溶劑)

○ 物理性危害(如噪音、輻射線、振動) ○ 人體功學危害 (如重複同樣動作) ○ 無

25.您經常做的運動爲何? 〈可複選〉

○ 輕度運動: 如園藝、掃地、拖地、打高爾夫球、玩棒球,、柔軟體操、舞蹈(一般)、騎腳踏車(慢速)

○ 中度運動: 如籃球、排球、乒乓球、羽毛球、舞蹈 (劇烈)、游泳 (隨意)、快速走路

○ 重度運動: 如慢跑 (8公里/小時)、爬山、爬樓梯、游泳(自由式或仰式)

○ 劇烈運動: 如跑步(12公里/小時)、跳繩、賽舟、游泳(蝶式)、溜冰比賽

26.您固定做運動的時間有多少?

○ 沒有或每週少於1小時 ○ 每週運動１-2小時 ○ 每週運動3-4小時 ○ 每週運動5-6小時 ○ 每週運動7小時以上

27.您每天睡眠時間有多少? ○ 4小時以下 ○ 4-6小時 ○ 6-8小時 ○ 8小時以上

28.您最近一個月入睡的情形如何? ○ 不易入睡 ○ 能入睡但易被吵醒 ○ 多夢

○ 需要安眠藥或鎮靜劑 ○ 熟睡

個人及家族病史

29.您長期持續服用的藥物有哪些?〈可複選〉(平均每日服用一次以上的藥物稱之)

○ 無服用任何藥物 ○ 尿酸藥物 ○ 心臟病藥物 ○ 高血壓藥物 ○ 糖尿病藥物

○ 甲狀腺藥物 ○ 高血脂藥物 ○ 氣喘藥物 ○ 鎮定劑或安眠藥 ○ 類固醇藥物

○ 荷爾蒙 ○ 止痛藥 ○ 腸胃藥 ○ 中藥 ○ 精神科藥物 ○ 自購成藥 ○ 其他

30.您對藥物過敏嗎? ○ 否 ○ 是 ○ 不知道

31.您曾患下列疾病嗎?〈可複選〉

○ 鼻咽癌 ○ 肺癌 ○ 乳癌 ○ 胃癌 ○ 肝癌 ○ 直腸癌 ○ 子宮頸癌

○ 攝護腺癌 ○ 其它癌症 ○ 高血壓 ○ 糖尿病 ○ 甲狀腺疾病 ○ 心臟血管疾病 ○ 腦血管疾病(中風)

○ 氣喘 ○ 結核性疾病 ○ 消化性潰瘍 ○ 肝炎 ○ 肝硬化 ○ 腎病 ○ 泌尿系統結石

○ 痛風 ○ 貧血 ○ 關節炎 ○ 其它 ○ 無以上疾病

32.請問您有否動過手術?〈可複選〉

○ 腦 ○ 眼 ○ 甲狀腺 ○ 耳鼻喉 ○ 肺 ○ 心臟 ○ 胸(包括乳房)

○ 胃 ○ 膽囊或膽管 ○ 腎臟 ○ 闌尾(盲腸)切除 ○ 其它消化器官(肝、胰、腸、其他)

○ 攝護腺 ○ 婦科(子宮、卵巢、輸卵管、其他) ○ 骨科 ○ 其它 ○ 無

33.您的親屬中(祖父母、父母、兄弟姊妹及子女)有無患下列疾病? (可複選)

○ 鼻咽癌 ○ 肺癌 ○ 乳癌 ○ 胃癌 ○ 肝癌 ○ 直腸癌 ○ 子宮頸癌

○ 攝護腺癌 ○ 其它癌症 ○ 高血壓 ○ 糖尿病 ○ 腦血管疾病(中風) ○ 心臟血管疾病

○ 家族性貧血 ○ 其它家族性疾病 ○ 無以上疾病

近況

• 請依您最近一個月的狀況作答：

	不會	偶爾	經常	每日
1.您的下肢有浮腫現象嗎？	○	○	○	○
2.您的關節有紅腫變形嗎？	○	○	○	○
3.您呼吸時聽到胸部類似咻咻的聲音嗎？	○	○	○	○
4.您的痰中是否有血絲？	○	○	○	○
5.您近來有吞嚥困難嗎？	○	○	○	○
6.您近來有不尋常的食慾不佳嗎？	○	○	○	○
7.您肚子餓時，胃會痛嗎？	○	○	○	○
8.您吃完飯後，胃會痛嗎？	○	○	○	○
9.您最近大便帶有鮮血嗎？	○	○	○	○
10.您最近大便有黑便現象嗎？	○	○	○	○
11.以前固定的排便習慣近來突然改變(次數、時間、形狀變化)？	○	○	○	○
12.您近來有血尿嗎？	○	○	○	○
13.您有耳鳴嗎？	○	○	○	○
14.您有暈眩嗎？	○	○	○	○

【第二面】【請至第三面繼續作答】

美兆診所

美兆自動化健檢 MJ AMHTS

(健康問卷 03)

否 是

15.您的體重在最近三個月內有減少4公斤以上嗎？ ○ ○

16.您最近一個多月是否一直不停的咳嗽？ ..... ○ ○

17.您是否患有痔瘡？ ..... ○ ○

18.您痣的顏色或大小是否起了變化？ ..... ○ ○

19.您的身體表面是否有一個多月不痊癒的瘤或傷口？ ○ ○

20.您頸部有硬塊嗎？ ..... ○ ○

21.您連續一個月口中有潰爛或白點存在？ ..... ○ ○

女性〈女性請往下作答，男性請跳至第38題〉

22.您是否已經停經(一年內無月經)？ ..... ○ ○

A.是，停經年齡：○ 40歲以下

41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 其他

○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○

B.否，最近一次月經日期： ○ 今年 ○ 去年

月： ○○ 1 2 3 4 5 6 7 8 9 10 11 12

日：十位數 ○○○ 1 2 3 個位數 ○○○○○○○○○○ 0 1 2 3 4 5 6 7 8 9

否 是

23.是否有不正常出血？ ..... ○ ○

24.您在性行爲後有出血情形？ ..... ○ ○

25.是否有月經過多的情形？ ..... ○ ○

26.是否曾有經痛？ ..... ○ ○

27.月經期幾天結束： ○ 4天以內 ○ 5天 ○ 6天 ○ 7天以上

28.您的月經週期不規則？ ..... ○ ○

29.是否曾患過婦科疾病？ ..... ○ ○

30.是否曾接受子宮切除或其它婦科手術？ ..... ○ ○

否 是

31.您的乳部有疼痛或硬塊現象(與經期無關者)？ ..... ○ ○

發生在： ○ 左側 ○ 右側 ○ 雙側

32.您的乳頭有分泌物或乳部變形的情形？ ..... ○ ○

發生在： ○ 左側 ○ 右側 ○ 雙側

33.是否曾經生育？ ..... ○ ○

懷孕次數 ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5(含)以上

生產次數 ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5(含)以上

34.是否採用避孕方法？ ..... ○ ○

採用方法 ○ 避孕套 ○ 口服避孕藥 ○ 子宮內避孕器 ○ 結紮手術

35.是否長期服用荷爾蒙藥物？ ..... ○ ○

36.是否曾接受乳房手術？ ..... ○ ○

37.母親、姊妹是否患有乳癌、卵巢癌、子宮內膜癌？ ○ ○

男性〈男性請往下作答，女性請跳至飲食評估題〉

38.您的兩側睪丸大小差異很大？ ..... ○ ○

39.睪丸大小近半年來有無變化？ ..... ○ ○

40.睪丸或陰囊是否有時疼痛？ ..... ○ ○

41.是否因疝氣、精索靜脈曲張或攝護腺開刀？ ..... ○ ○

42.小便是否有困難？ ..... ○ ○

43.夜裡是否需要起床解小便？〈回答是者請續答第44題〉 ○ ○

44.次數： ○ 1-2次 ○ 3-4次 ○ 5次以上

飲食評估

• 請您回想平日的飲食狀況，並在下列各項問題中，選擇一個最接近的答案。我們將依您提供的資料，爲您評估每日所攝取的營養量，並給您最適當的飲食建議。「請務必逐題填寫清楚，以便於爲您服務」謝謝！

1.您用餐是否定時定量？ ○ 否 ○ 是

2.您是否爲全日素食者？ ○ 否 ○ 是〈全日素食者第3、4、5題可依本身情況選答，或跳至第9題〉

3.牛奶(含羊奶)喝多少？(1杯相等於鮮奶240c.c、優酪乳一杯240c.c.或奶粉4平湯匙)

○ 不喝或每週少於1杯 ○ 每週喝1-3杯 ○ 每週喝4-6杯 ○ 每天喝1杯 ○ 每天喝2杯或以上

4.乳製品吃多少？(1份相當於酸奶酪或起司1片)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

5.蛋類吃多少？(1份相當於雞蛋或鴨蛋1個、或鵪蛋5個)〈全日素食者請跳答第9題〉

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

6.肉類(含豬、雞、鴨、牛、羊肉)吃多少？(1份相當於豬牛排1片〈約手掌大小厚1公分〉、或棒棒腿1支、或漢堡肉1塊、或其他瘦肉約4湯匙)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

7.水產類吃多少？(1份相當於中型秋刀魚1尾、或生魚片4片、或魚肉4湯匙、或草蝦4尾、蚵16粒)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

【第三面】【請翻至第四面繼續作答】 請下方向

美兆診所

美兆自動化健檢
MJ AMHTS

NO.

(健康問卷 04)

編碼

8.內臟類(如肝、腎、心、腸等)吃多少？(1份相當於豬肝或雞肝半碗、雞心8個、熟豬腸4湯匙)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

9.豆類及豆製品吃多少？(1份相當於盒裝豆腐半盒、或豆漿1杯240c.c.、或五香豆乾2塊、或豆包手掌大半片)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

10.淡色蔬菜(如高麗菜、白菜、黃瓜、蘿蔔及其他淡色蔬菜)吃多少?

○ 不吃或每天少於半碗 ○ 每天吃半碗-1碗以內 ○ 每天吃1碗-1碗半以內 ○ 每天吃1碗半-2碗以內 ○ 每天吃2碗或以上

11.深色蔬菜(如胡蘿蔔、菠菜、南瓜、蕃茄、空心菜及其他深黃綠色蔬菜)吃多少?

○ 不吃或每天少於半碗 ○ 每天吃半碗-1碗以內 ○ 每天吃1碗-1碗半以內 ○ 每天吃1碗半-2碗以內 ○ 每天吃2碗或以上

12.以上蔬菜中用油炒或加沙拉醬的有多少？

○ 不吃或每天少於半碗 ○ 每天吃半碗-1碗以內 ○ 每天吃1碗-1碗半以內 ○ 每天吃1碗半-2碗以內 ○ 每天吃2碗或以上

13.水果類吃多少？(1份相當於中型蘋果或葡萄柚或土芭樂半個、柳丁或橘子或奇異果1個、木瓜或西瓜半斤、荔枝5顆、葡萄或龍眼12粒)

○ 不吃或每天少於1份 ○ 每天吃1份-2份以內 ○ 每天吃2份-3份以內 ○ 每天吃3份-4份以內 ○ 每天吃4份或以上

14.飯或麵製品吃多少? (1份相當於1飯碗的飯、或2飯碗的麵、16個水餃皮、4片薄的土司、饅頭1個、燒餅油條2套)

○ 不吃或每天少於1份 ○ 每天吃1份-2份以內 ○ 每天吃2份-3份以內 ○ 每天吃3份-4份以內 ○ 每天吃4份或以上

15.以上飯或麵製品屬於全穀類的有多少? (1份相當於全麥麵包4片、糙米飯或五穀雜糧飯1碗、麥片8湯匙)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

16.以上的飯或麵製品是用油炒或加油製成的有多少? (1份相當於炒飯、炒麵、炒米粉1碗、或燒餅油條2套)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

17.根莖類(如地瓜、馬鈴薯、芋頭、菱角等)吃多少?

○ 不吃或每週少於半碗 ○ 每週吃半碗-1碗半 ○ 每週吃2-3碗 ○ 每天吃半碗 ○ 每天吃1碗或以上

18.麵包吃多少？ (1份相當於紅豆麵包1個、或奶酥麵包1個、或蛋糕1塊、或甜餅乾15片)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

19.有沒有吃加果醬或蜂蜜的食物？(1份相當於果醬或蜂蜜2茶匙)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

20.有沒有喝加糖的咖啡、可可、茶、果汁或飲料? (如汽水、綠豆湯，1杯爲240c.c.)

○ 不喝或每週少於1杯 ○ 每週喝1-3杯 ○ 每週喝4-6杯 ○ 每天喝1杯 ○ 每天喝2杯或以上

21.平常用油炸的、或用油煎的食物吃多少？(1份以半碗計)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

22.您平常額外補充何種營養品或保健食品？〈可複選〉

○ 無 ○ 維生素 C ○ 維生素 E ○ 鈣質 ○ 鐵劑 ○ 多種維他命 ○ 甲殼素 ○ 植物纖維

○ 含ω-3脂肪酸的魚油 ○ 魚肝油 ○ 卵磷脂 ○ 蜂膠 ○ 藻類 ○ 花粉 ○ 乳酸菌 ○ 其它中草藥

23.醬菜類、或加工品(如火腿、香腸、罐頭食品等)、或鹹魚類吃多少?(1份約1湯匙醬菜、香腸半根、火腿片2片、罐頭肉類1湯匙)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

24.您吃速食麵嗎?(1份相當於速食麵1碗或1包)

○ 不吃或每週少於1份 ○ 每週吃1-3份 ○ 每週吃4-6份 ○ 每天吃1份 ○ 每天吃2份或以上

25.您用餐時是否有沾醬油或其他含鹽份佐料的習慣? (1份相當於2茶匙醬油、蕃茄醬或辣椒醬、黑醋、1茶匙胡椒鹽)

○ 不用或每週少於1份 ○ 每週1-3份 ○ 每週4-6份 ○ 每天1份 ○ 每天2份或以上