Original Article
E Joint and Sports Sci. 2025; (02):15-22
ISSN 3023-3453

Emerging Joint and Sports Sciences EJSS

Relationship between Physical Activity and Hip Bone Mineral Density for Middle-Aged Women in the United States

Joshua O. Seelall
MPH, CIC

Abstract

Background
Osteoporosis and decline in bone health in the elderly are very common. Such medical problems in middle-aged women can lead to hip fractures and other related problems.

Objective
In this research paper, I empirically evaluate whether women in the United States who do the same or higher physical activity (compared to other women of the same age) have different hip bone mineral density at 10 years than women who do less physical activity (compared to other women of the same age) in the USA.

Methods
I used the SWAN dataset tracked over 10 years for the same individuals. The sample size is 1513 respondents. The exposure/treatment is physical activity. The outcome variable is total hip bone mineral density. The population is middle-aged women in the USA. I used chained multiple imputations with ordinary least squares regressions along with maximum likelihood logistic and multinomial logistic models using 18 imputations. I also used summary statistics (simple and detailed), chi-squared tests, mean comparison 2-tailed t-tests, correlations, histograms, and ordinary least squares regression estimates with post-estimation tests such as the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity.

Results
Both the bivariate and multivariate OLS models show that total hip bone mineral density for middle-aged women in the USA increases (after 10 years) for women who engage in higher physical activity during baseline. I find that women who engage in higher physical activity have, on average, 0.027 higher total hip bone mineral density than women who do not engage in physical activity as much in the USA, ceteris paribus.

Conclusions
I found physical activity to be a statistically significant determinant for total hip bone mineral density, along with age, BMI, marital status, race, calcium intake, alcohol consumption, and smoking status for middle-aged women in the United States. I recommend that middle-aged women in the USA participate in physical activity regularly, such as walking, strength training, swimming, etc., to increase their total hip bone mineral density and avoid osteoporosis.

Introduction

Osteoporosis is a bone disease characterized by low bone mineral density (BMD) and increased risk of bone fractures because of decreased bone strength, especially for women after midlife (NIAMS, 2022). Osteoporosis develops when bone mass and mineral density decrease. Bone mineral density is important since it measures calcium and other minerals in bones and is an important indicator of bone strength (NIAMS, 2025). This bone disease is a significant public health challenge, especially for women after midlife. Among many other problems, osteoporosis also results in hip fractures. These decreases in hip bone mineral density and increasing hip fractures can result in severe morbidity, mortality, and healthcare costs for women, especially after midlife. Hence, maintaining adequate bone mineral density is necessary for the prevention of osteoporosis. Physical activity is an important lifestyle factor that plays a significant role in maintaining bone health and mineral density, i.e., physical activity aids in the prevention of osteoporosis. (Daly et al., 2019). Research shows that weight-bearing physical activity, such as walking, running, and strength training, signals the body to increase osteoblast activity, i.e., signal cells to form new bone tissues, thus increasing bone mineral density over time. Hence, it is important to study the relationship between physical activity and hip bone mineral density, especially in middle-aged women.

Many research papers have focused on the relationship between physical activity and bone mineral density. I focus on 5 scholarly peer-reviewed research papers from PubMed with a very similar research question. The summary of these papers is reported in Table 1 of the Appendix for the ease of the readers. The cross-sectional research studies show a positive and direct statistically significant relationship between physical activity and hip bone mineral density of the elderly, especially women. These cross-sectional research studies recommend that male and female patients (White, aged, normal vs. low hip BMD, etc.) focus on physical activity and leave sedentary behavior to improve their total hip bone mineral density (Brownbill et al., 2003; Chopra et al., 2020; Mikkilä et al., 2024). Similarly, the prospective cohort research studies measure the long-term effects of physical activity on total hip bone mineral density and find that patients/respondents who focus on physical activity over the years have higher hip bone mineral densities and fewer chances of hip fractures compared to their peers who do less physical activity (Mikkilä et al., 2022; Nokes & Tucker, 2012). Wolff's law can help us understand this phenomenon. It states that human bones adapt to mechanical loads (such as stress caused by weight-bearing physical activity) to become stronger and denser (Frost, 1994). All these peer-reviewed research papers explain the relationship between physical activity and hip BMD using different research designs. This research paper also focuses on the relationship between physical activity and hip BMD, but in a different way, i.e., only for middle-aged women in the United States over 10 years. This research paper empirically evaluates whether women in the United States who do the same or higher (self-reported) physical activity compared to other women of the same age have different hip bone mineral density at 10 years than women who do less physical activity (self-reported) compared to other women of the same age.

Methods

Data

I used a longitudinal dataset from the Study of Women's Health Across the Nation (SWAN) for the United States. The SWAN dataset is an epidemiologic study designed to examine the health of middle-aged women in the United States of America (USA) as they transition through menopause and beyond. The final SWAN dataset, after multiple imputations and keeping only non-missing observations, had repeated observations of the same 1513 individuals over 10 years.

The sample I chose for this research paper, from the given SWAN dataset, comprised variables related to the research question. We only focus on variables and empirical methodologies we found relevant during our research on the existing literature in the field (also discussed in the introduction section).

Measures

Exposure

The exposure or treatment in the research study is physical activity (high vs. low). Thus, Physical_i is the main independent variable of interest. The treatment starts at year 1 for the SWAN respondents.

Outcome

The outcome or dependent variable in the Ordinary Least Squares (OLS) multilinear regression model is the total hip bone mineral density at 10 years.

Covariates

I tried to include different socioeconomic (income level, education level), demographic (age, race, marital status), lifestyle (alcohol consumption, smoking status), and nutritional (vitamin intake, calcium intake, hormone use) factors available in the SWAN dataset that could affect the relationship between physical activity and hip bone mineral density, especially in middle-aged women in the USA. I use age since bone mineral density (BMD) normally changes with age, i.e., children have a relatively lower bone mineral density than adults. I use a dummy variable for smoking status since smoking can negatively affect bone mineral density. I also control for alcohol consumption since excessive alcohol consumption can negatively affect bone health and mineral density. Excessive alcohol consumption and smoking decrease BMD by increasing osteoclast activity and reducing osteoblast function in cells. They also reduce calcium absorption and alter hormone levels. I also use a categorical variable for dietary calcium intake and a dummy variable for any vitamin intake since these are important for bone health and bone mineral density (particularly vitamin D, vitamin K, vitamin C, and B vitamins). For example, vitamin D helps the body absorb calcium, which in turn increases bone mineral density. I use body mass index since BMI influences bone loading and density. I also control for race using a categorical variable since people with different genetics and races can have different bone densities: for example, skin color affects vitamin D creation, which affects how the body uses minerals like calcium, so it may be related to bone density. Furthermore, I also control other factors using a categorical variable for total family income, a dummy variable for any hormone intake, and a categorical variable for marital status.

Statistical Analysis

Before discussing different measures and the empirical model, I want to discuss the lack of data and missing observations in the SWAN dataset. The given SWAN dataset had a lot of missing observations for most of the variables that were required for the empirical analysis, i.e., over 74% of the overall data across all the variables was missing (not due to skip patterns). Hence, I imputed (filled) most missing observations in the SWAN dataset using the chained multiple imputation method with three different models: Ordinary Least Squares (OLS) regression (reg), logistic regression (logit), and multiple logistic regression (mlogit). I imputed the continuous variables (Age, BMI) with an OLS regression, dummy variables (Hormone use, physical activity) with a logit model, and a multiple logit model for the nominal/unordered variables (race, marital status, income level, vitamin intake, calcium intake). I tested the models using different numbers of imputations (3 and 18) and found out that the regression coefficients (discussed later in the paper) do not vary much. This shows that the imputation approach was robust and does not affect (or bias) the regression estimates.

The summary statistics for the variables used in the empirical analysis are reported in Table 2 of the Appendix. It helps us better understand the data by providing information on the total number of observations, average (mean), standard deviation, minimum, and maximum value for each of the variables. As discussed, I have a total of 1513 observations in the dataset, and no missing observations (since I have already imputed the SWAN dataset). The average total hip bone mineral density for middle-aged women in the USA in the SWAN dataset is 0.907, i.e., a normal BMD range. The average age of respondents in the sample dataset is 47 years. Similarly, the average BMI in the sample dataset is 27.224. The remaining estimates in the table can be interpreted similarly. However, this table is not very helpful for dummy or categorical variables. Hence, to understand the data better, I present Table 3 to the readers.

The detailed summary statistics are reported in Table 3 of the Appendix. I present the frequency count and % of total for each category within the categorical variables and dummy variables in the dataset. I also report p-value for the chi-squared test to compare categorical variables (such as race, income, etc.) across the exposure (less vs. same or more physical activity). Similarly, I also used the mean-comparison 2-tailed t-tests to compare continuous variables (such as BMI, total hip bone mineral density, etc.). For example, out of the total sample, 344 middle-aged women in the USA report that they do less physical activity compared to women of the same age in the USA, whereas 1169 have reported that they engage in the same or more physical activity. The average total hip bone mineral density for middle-aged women who do less physical activity is 0.921, whereas it is 0.903 for women who do the same or more physical activity. Surprisingly, total hip BMD is lower for women who engage in physical activity. The 2-tailed mean-comparison t-test also gives a p-value of 0.0328, suggesting that the average total hip BMD is different across the 2 physical activity levels at the 5% Significance Level. The remaining estimates in the table can be interpreted similarly.

The correlation matrix for all relevant variables in the study to determine the effect of physical activity on total hip bone density is reported in Table 4 of the Appendix. It provides us pairwise correlations for each pair of variables in the SWAN dataset alongwith the respective p-values for statistical significance. The correlation matrix provides us an idea about the direction and strength of relationship between different variables. For example, the correlation between total hip bone mineral density for middle aged women in the USA and their BMI is 0.603. This tells us that there is a very strong relationship between BMI and total hip BMD for middle-aged women in the USA. Also, this correlation has a p-value of 0.000, it is statistically significant at the 5% Significance Level. The remaining estimates can also be interpreted similarly.

In this research paper, I estimate 3 different OLS multilinear regression models to determine the relationship between physical activity and total hip bone mineral density. I vary the covariates between each of these 3 models. The mathematical model specification for the preferred OLS regression model (based on reasons discussed in the next section) is:

$$\begin{aligned} \mathrm{Hip\_BMD_i} = {} & \beta_0 + \beta_1 \mathrm{Physical_i} + \beta_2 \mathrm{Age_i} + \beta_3 \mathrm{Race_i} \\ & + \beta_4 \mathrm{Marital\_Status_i} + \beta_5 \mathrm{Vitamin_i} \\ & + \beta_6 \mathrm{Calcium_i} + \beta_7 \mathrm{Alcohol_i} + \beta_8 \mathrm{Smoker_i} \\ & + \beta_9 \mathrm{Income\_level_i} + \beta_{10} \mathrm{BMI_i} \\ & + \beta_{11} \mathrm{Hormone\_use_i} + \mathrm{e_i} \end{aligned}$$

Furthermore, I also used the Breusch-Pagan/Cook-Weisberg test to check for potential heteroskedasticity in all 3 of the OLS regression models. I use the statistical test instead of looking at the residuals plot since the p-value of the test helps us make a precise decision. Based on the p-values for this test, we use heteroskedasticity robust standard errors in all 3 of the regression models.

Results

I also check the distribution of the outcome variable (total hip bone mineral density) before estimating the OLS regression models. Figure 1 of the Appendix provides a histogram for the dependent variable. I can see that it is normally distributed and has very small skewness or kurtosis. Hence, no transformation (log, inverse hyperbolic, etc.) is required. Similarly, I also present the histograms of the outcome variable by the binary exposure variable. It is presented in Figure 2 of the Appendix. I can see that total hip BMD is also normally distributed for both levels of physical activity. Hence, I proceed to the regression models.

The estimates for all 3 of the OLS regression models are reported in Table 5 of the Appendix. All 3 of the OLS regression models are individually statistically significant at the 5% Significance Level, based on the p-values from the overall F-test of model statistical significance. However, the coefficient of determination or R-squared is highest for Model 3 among all 3 models, i.e., 0.429. This tells us that the OLS regression model 3 can estimate 42.9% of the variations in total hip bone mineral density (cross-calibration applied). Hence, I will be only focusing on Model 3, i.e., the preferred model with all covariates.

The regression coefficient on the exposure/treatment variable $\mathrm{Physical_i}$ is 0.027. This can be interpreted as the total hip bone mineral density for a middle aged woman in the USA who engages in more physical activity compared to women of the same age is, on average, 0.027 units higher than the total hip BMD for a middle aged women in the USA who engages in less physical activity, ceteris paribus. This regression estimate is statistically significant at the 5% Significance Level.

Similarly, the regression coefficient on age in Model 3 of Table 5 is -0.006. This can be interpreted as when the age of a middle-aged woman in the USA increases by 1 year, on average, I can expect her total hip bone mineral density to decrease by 0.006 units, ceteris paribus. This regression estimate is also statistically significant at the 5% Significance Level.

All remaining estimates in Table 6 can also be interpreted similarly. It is to be noted that the variables for vitamin intake, total family income, and hormone usage are not statistically significant determinants of total hip BMD for middle-aged women in the USA. Lastly, Figure 3-5 in the Appendix of this report presents the regression estimates of all 3 OLS regression models graphically.

Discussion

Given the results, I find that physical activity can significantly help middle-aged women in the USA increase their total hip bone mineral density. Thus, the research shows that physical activity can significantly help in the prevention of osteoporosis (especially related to total hip bone mineral density). The result is in line with past research on the subject, i.e., physical activity increases bone mineral density (in different bones) and prevents osteoporosis. Therefore, I advise doctors and caregivers to strongly recommend physical activity to patients suffering from total bone mineral density and osteoporosis. I advise everyone, especially middle-aged women in the USA, to make physical activity a routine task. Also, I advise policymakers and governments to focus on providing better recreational facilities to people where they can not only do physical activity but also raise awareness about the importance of physical activity to improve the overall health and living standard of middle-aged women in the United States. I advise future researchers to use a more extensive dataset and replicate the empirical methodology to verify the results. I also recommend that future researchers focus on models other than OLS regressions to predict total hip bone mineral density in middle-aged women in the United States of America.

Strengths and Limitations

I consider the empirical methodology to be robust since I use a sound imputation technique with 18 imputations and chained OLS, logit, and mlogit models to predict missing observations in the SWAN dataset. I ensured the imputation was done correctly by estimating multiple chained models with different numbers of imputations. Furthermore, I also believe that the overall empirical methodology is very robust, i.e., I use summary statistics (simple and detailed), chi-squared tests, mean comparison 2-tailed t-tests, correlations, histograms, and Ordinary Least Squares regression estimates with post-estimation tests such as the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity.

Despite the strengths, the empirical methodology also has some limitations. Although the imputation method was very technically sound, it is always better to have correct and complete data at the start. Also, I estimate the relationship between total hip bone mineral density and physical activity for middle-aged women in the USA using a very small sample size, i.e., only 1513 observations (respondents). The sample size might be a bit too small to generalize the research findings given the huge population of the United States. Lastly, I fear that the OLS regression estimates might suffer from omitted variable bias since I could not control for every factor that could affect the total hip bone mineral density for middle-aged women in the USA. For example, the OLS regression model does not account for the history of bone diseases in patients, and it does not include data on previous medications that the patient was taking. These factors can have an important effect on the BMD of middle-aged women in the USA.

Conclusion

Concluding this research paper, I used a longitudinal SWAN dataset to estimate the relationship between total hip bone mineral density and physical activity for middle aged women living in the United States over 10 years. The OLS multilinear regression models show that physical activity is important to maintain and increase total hip bone mineral density for middle aged women in the USA. I also find that factors such as age, BMI, marital status, race, calcium intake, alcohol consumption, and smoking are also statistically significant determinants of total hip bone mineral density for middle aged women in the USA.

References

1. Brownbill, R. A., Lindsey, C., Crncevic–Orlic, Z., & Ilich, J. Z. (2003). Dual Hip Bone Mineral Density in Postmenopausal Women: Geometry and Effect of Physical Activity. Calcified Tissue International, 73(3), 217–224. https://doi.org/10.1007/s00223-002-1066-x
2. Chopra, S., Morrow, M. M., Ngufor, C., & Fortune, E. (2020). Differences in Physical Activity and Sedentary Behavior Patterns of Postmenopausal Women With Normal vs. Low Total Hip Bone Mineral Density. Frontiers in Sports and Active Living, 2, 83. https://doi.org/10.3389/fspor.2020.00083
3. Arefin, S., & Simcox, M. (2024). AI-Driven Solutions for Safeguarding Healthcare Data: Innovations in Cybersecurity. International Business Research, 17(6), 1-74.

4. Frost, H. M. (1994). Wolff's Law and bone's structural adaptations to mechanical usage: An overview for clinicians. 175–188. https://doi.org/10.1043/0003-3219(1994)064<0175:WLABSA>2.0.CO;2.
5. Mikkilä, S., Handegård, B. H., Johansson, J., Hopstock, L. A., Van Den Tillaar, R., Emaus, N., Morseth, B., & Welde, B. (2024). Cross-sectional associations between accelerometer-measured physical activity and hip bone mineral density: The Tromsø Study 2015-2016. JBMR Plus, 8(7), ziae061. https://doi.org/10.1093/jbmrpl/ziae061
6. Mikkilä, S., Johansson, J., Nordström, A., Nordström, P., Emaus, N., Handegård, B. H., Morseth, B., & Welde, B. (2022). A 15-year follow-up study of hip bone mineral density and associations with leisure time physical activity. The Tromsø Study 2001–2016. PLOS ONE, 17(1), e0262228. https://doi.org/10.1371/journal.pone.0262228
7. Nokes, N. R., & Tucker, L. A. (2012). Changes in Hip Bone Mineral Density and Objectively Measured Physical Activity in Middle-Aged Women: A 6-Year Prospective Study. American Journal of Health Promotion, 26(6), 341–347. https://doi.org/10.4278/ajhp.100622-QUAN-208

Appendix

Figure 1: Histogram of total hip bone mineral density (cross-calibration applied)

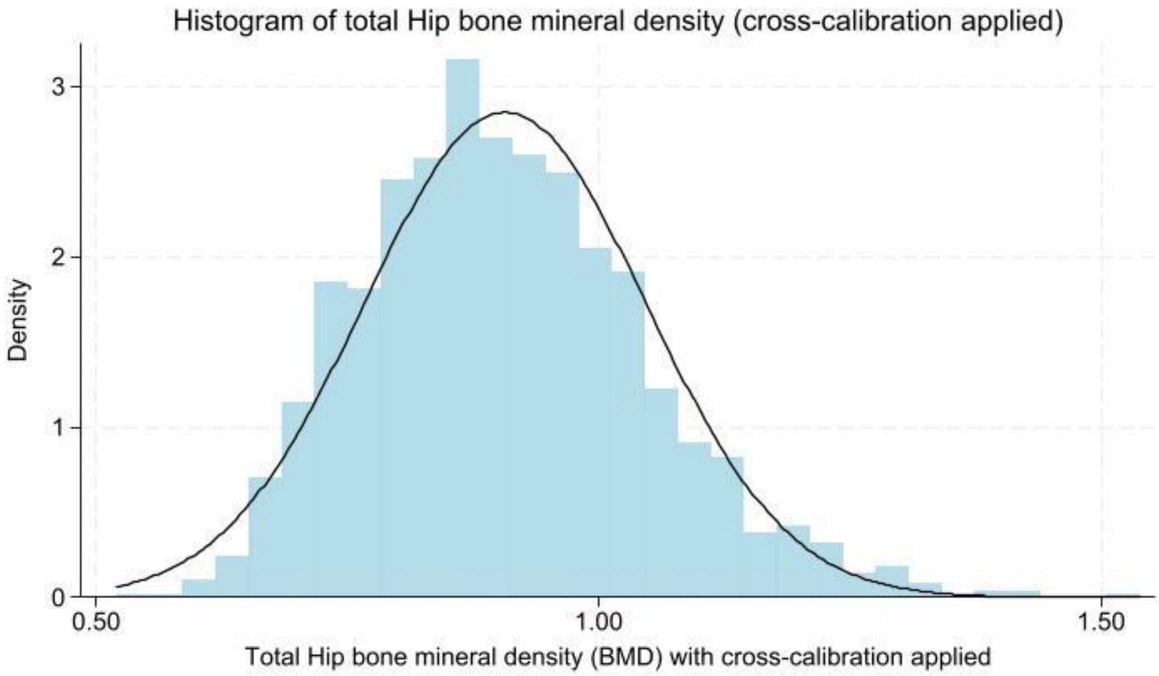

Figure 2: Histogram of total hip bone mineral density (cross-calibration applied) by physical activity

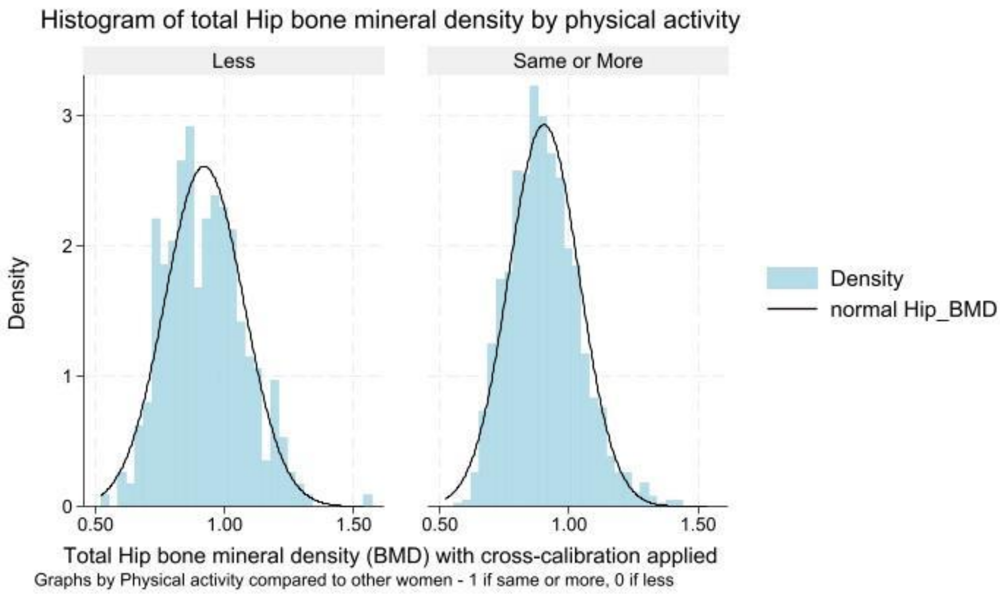

Figure 3: Regression coefficient plot for Model 1

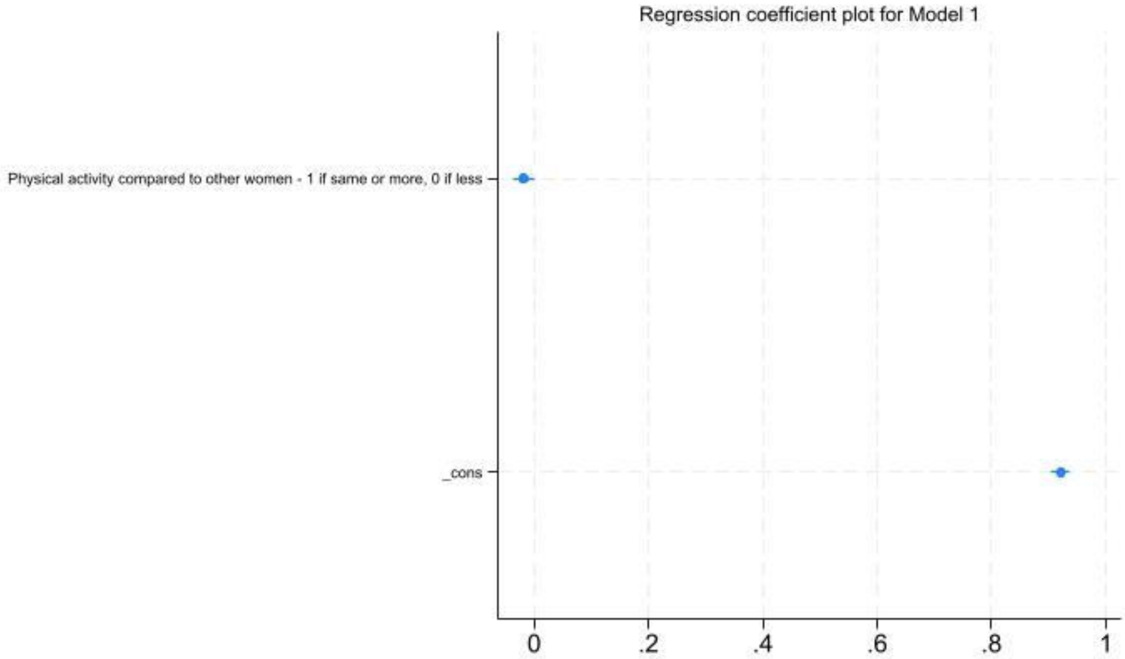

Figure 4: Regression coefficient plot for Model 2

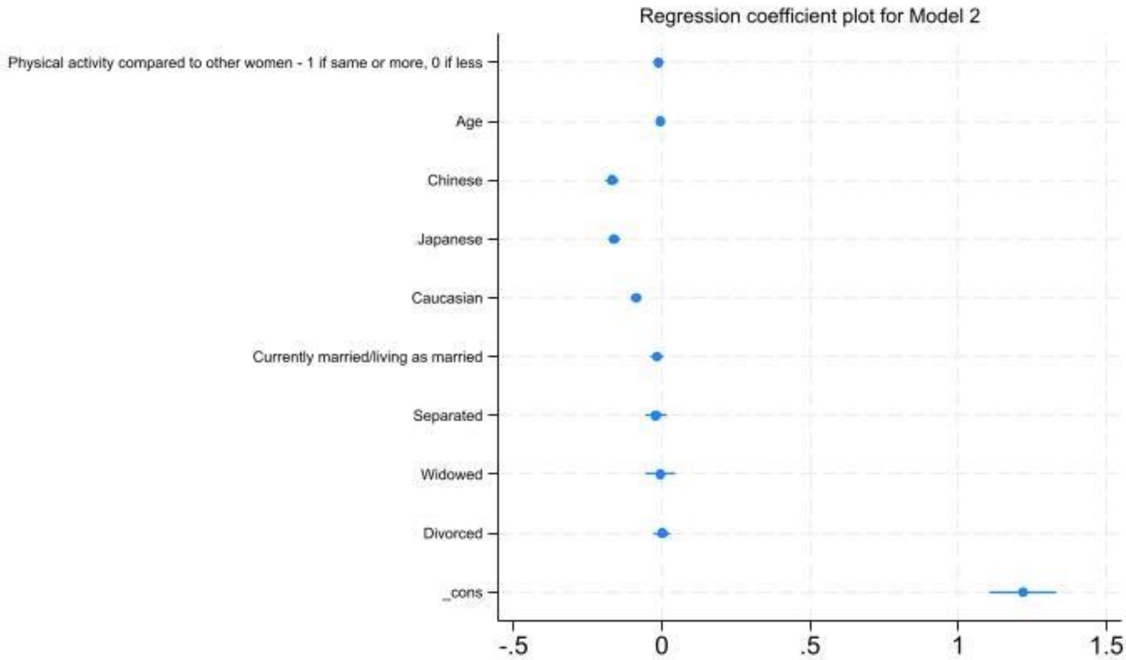

Figure 5: Regression coefficient plot for Model 3

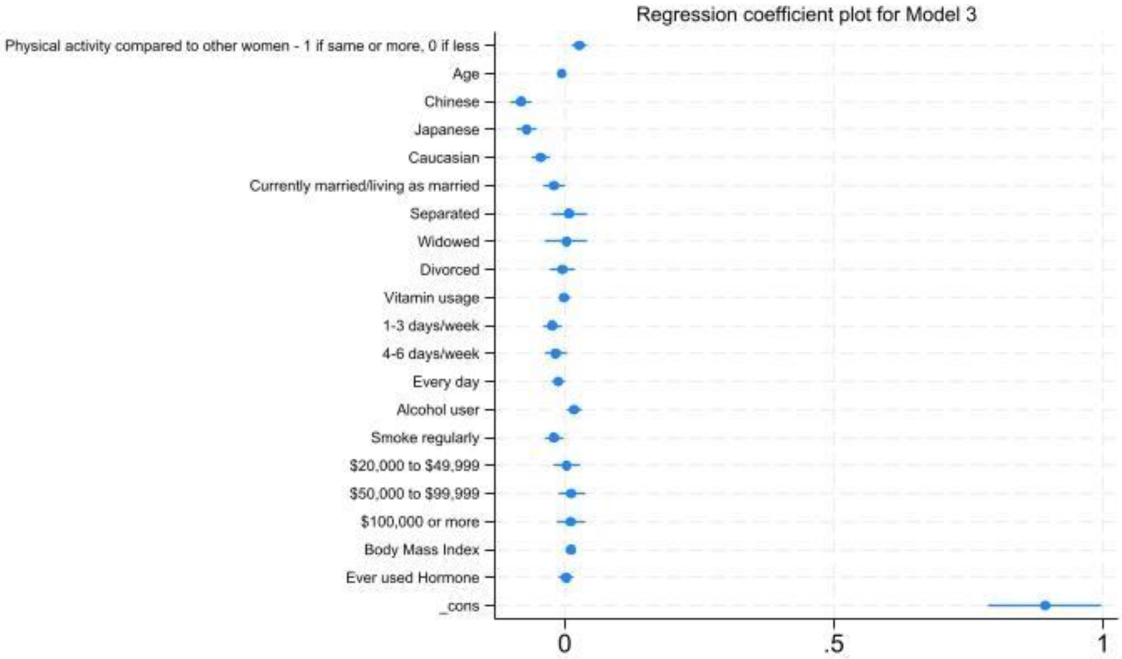

Table 1: Literature summary

Citation	Population/Sample	Exposure	Outcome	Research design
(Brownbill et al., 2003)	57.4-88.6 years postmenopause Caucasian women	Physical activity	Dual hip bone mineral density	Cross-sectional
(Chopra et al., 2020)	46-79 years postmenopause women with normal vs. low total hip bone mineral density	Physical activity vs. sedentary behavior patterns	Total hip bone mineral density	Cross-sectional
(Brownbill et al., 2003)	32-86 years old men and women in Norway (2001-2016)	Leisure time physical activity	Hip areal bone mineral density (BMD)	Prospective cohort
(Mikkilä et al., 2024)	40-84 years old men and women in Norway (2015-2016)	Accelerometer-measured physical activity	Total hip areal bone mineral density	Cross-sectional
(Nokes & Tucker, 2012)	35-45 years (middle-aged) non-smoking women	Physical activity	Hip bone mineral density changes over 6 years	Prospective cohort

Table 2: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Total Hip bone mineral density	1513	.907	.14	.52	1.539
Physical activity	1513	.773	.419	0	1
Age	1513	47.031	2.683	42	54
Race	1513	2.912	1.249	1	4
Vitamin usage	1513	1.59	.492	1	2
Calcium intake	1513	2.069	1.291	1	4
Alcohol user	1513	1.163	.369	1	2
Marital status	1513	2.357	1.153	1	5
Smoke regularly	1513	1.132	.338	1	2
Total family income	1513	2.711	.87	1	4
Body Mass Index	1513	27.224	6.501	14.335	49.169
Ever used Hormone	1513	.798	.402	0	1

Table 3: Summary statistics - Detailed

Variables	Less physical activity	Same or more physical activity	p-value
	N = 344	N = 1169	
Total hip bone mineral density, mean (sd)	0.921 (0.153)	0.903 (0.136)	0.0328
Age, mean (sd)	46.6 (2.51)	47.15 (2.72)	0.0016
Race, freq (%)			0.4
Black	91 (26.45%)	263 (22.5%)	

Chinese	39 (11.34%)	150 (12.83%)	
Japanese	49 (14.24%)	157 (13.43%)	
White	165 (47.97%)	599 (51.24%)	
Vitamin D usage at Baseline, freq (%)			0.211
No	151 (43.9%)	469 (40.12%)	
Yes	193 (56.1%)	700 (59.88%)	
Calcium intake at Baseline, freq (%)			0.991
Do not take any	184 (53.49%)	627 (53.64%)	
1-3 days/week	44 (12.79%)	143 (12.23%)	
4-6 days/week	25 (7.27%)	89 (7.61%)	
Every day	91 (26.45%)	310 (26.52%)	
Alcohol user at Baseline, freq (%)			0.626
No	291 (84.59%)	976 (83.49%)	
Yes	53 (15.41%)	193 (15.51%)	
Marital status at Baseline, freq (%)			0.368
Single/never married	52 (15.12%)	136 (11.63%)	
Currently married/living as married	228 (66.28%)	809 (69.2%)	
Separated	12 (3.49%)	39 (3.34%)	
Widowed	10 (2.91%)	24 (2.05%)	
Divorced	42 (12.21%)	161 (13.77%)	
Smoker at Baseline, freq (%)			0.021
No	286 (83.14%)	1028 (87.94%)	
Yes	58 (16.86%)	141 (12.06%)	
Total family income, freq (%)			0.001
Less than $19999	39 (11.34%)	87 (7.44%)	
$20000 to $49999	116 (33.72%)	360 (30.8%)	
$50000 to $99999	147 (42.73%)	473 (40.46%)	
$100000 or more	42 (12.21%)	249 (21.3%)	
Ever used Hormones (any), freq (%)			0.407
No	75 (21.8%)	231 (19.76%)	
Yes	269 (78.2%)	938 (80.24%)	
Body Mass Index, mean (sd)	29.993 (0.414)	26.41 (5.823)	0.000

Table 4: Correlation matrix

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
(1) Hip_BMD	1.000											
(2) Physical	-0.055	1.000										
	(0.033)											
(3) Age	-0.114	0.081	1.000									
	(0.000)	(0.002)										
(4) Race	-0.185	0.033	0.035	1.000								
	(0.000)	(0.206)	(0.172)									
(5) Vitamin	-0.078	0.032	0.133	0.078	1.000							
	(0.003)	(0.211)	(0.000)	(0.002)								
(6) Calcium	-0.207	0.001	0.121	0.192	0.026	1.000						
	(0.000)	(0.967)	(0.000)	(0.000)	(0.311)							
(7) Alcohol	-0.028	0.013	0.001	0.134	0.007	0.012	1.000					
	(0.284)	(0.626)	(0.972)	(0.000)	(0.798)	(0.630)						
(8) Marital_status	0.061	0.023	0.055	-0.089	-0.044	-0.053	-0.034	1.000				
	(0.017)	(0.372)	(0.032)	(0.001)	(0.087)	(0.039)	(0.188)					
(9) Smoker	0.035	-0.060	-0.060	-0.132	-0.117	-0.056	0.035	0.053	1.000			
	(0.177)	(0.021)	(0.020)	(0.000)	(0.000)	(0.030)	(0.171)	(0.041)				
(10) Income_level	-0.192	0.095	0.077	0.232	0.144	0.146	0.113	-0.229	-0.199	1.000		
	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
(11) BMI	0.603	-0.231	0.000	-0.169	-0.100	-0.220	-0.124	0.056	0.059	-0.246	1.000	
	(0.000)	(0.000)	(0.995)	(0.000)	(0.000)	(0.000)	(0.000)	(0.028)	(0.022)	(0.000)		
(12) Hormone_use	0.082	0.021	-0.010	0.046	-0.025	-0.018	0.070	0.080	0.060	0.037	0.084	1.000
	(0.001)	(0.408)	(0.694)	(0.072)	(0.336)	(0.495)	(0.006)	(0.002)	(0.020)	(0.149)	(0.001)	

Table 5: Ordinary Least Squares multilinear Regression models

Total bone mineral density	**(1)**	**(2)**	**(3)**
Physical activity	-.018**	-.012	.027***

	(.009)	(.008)	(.007)
Age		-.004***	-.006***
		(.001)	(.001)
Race Black (Reference group)			
Chinese		-.167***	-.081***
		(.011)	(.01)
Japanese		-.162***	-.071***
		(.011)	(.01)
White		-.086***	-.044***
		(.009)	(.008)
Marital status			
Single/never married (Reference group)			
Currently married/living as married		-.016	-.02**
		(.011)	(.01)
Separated		-.02	.008
		(.019)	(.016)
Widowed		-.005	.003
		(.025)	(.02)
Divorced		.002	-.004
		(.014)	(.012)
Vitamin			-.002
			(.006)
Calcium			
Do not take any (Reference group)			
1-3 days/week			-.023***
			(.009)
4-6 days/week			-.017
			(.011)
Every day			-.012*
			(.007)
Alcohol			.017**
			(.008)
Smoker			-.02**
			(.009)
Total family income Less than $19999 (Reference group)			
$20000 to $49999			.003
			(.012)
$50000 to $99999			.012
			(.013)
$100000 or more			.011
			(.014)
BMI			.012***
			(.001)
Hormone usage			.002
			(.007)
Constant	.921***	1.219***	.893***
	(.008)	(.058)	(.054)
Observations	1513	1513	1513
R-squared	.003	.197	.429
Robust standard errors are in parentheses			
*** p<.01, ** p<.05, * p<.1			