Average Ambient UVB and Osteoporosis in the Participants of the UK Biobank

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Introduction

- Osteoporosis is a progressive bone disease characterised by low bone density and micro-architectural deterioration of bone tissue [1].
- Vitamin D is important for bone health, and humans synthesise it through exposure to solar irradiation. Studies have shown the beneficial effect of long-term solar ultraviolet B exposure [2], though evidence regarding long term solar ultraviolet B (UVB) exposure for weighing risks against the benefits is limited.
- This study addresses the hypothesis that increased average lifetime ambient UVB radiation might have a beneficial effect on preventing osteoporosis in later life.

Key Findings

- Osteoporosis has been found in only 1% of the participants.
- The mean of the ambient UVB exposure was 93 milliwatt/meter^2.
- After adjusting for other covariates, the odds of osteoporosis were not associated with average ambient UVB exposure.

Methods

- Cross-sectional method were applied utilising baseline measures from the United Kingdom Biobank cohort. The final sample included 186,844 (37%) participants aged 40-69 years at recruitment during 2006 to 2010 with heel sonography measurements and had UVB data.
- **Outcome variable:** Diagnosed osteoporosis (Defined by T score -2.5 Standard Deviation or below.
- **Main exposure variable:** Average ambient Solar UVB irradiance. Participant's residential address were used to allocate the monthly ambient UVB values. These values were averaged (period 2000-2015) to estimate yearly average. The lifetime average ambient UVB was estimated by taking the weighted average of the ambient UVB at birthplace and place of baseline residence (the length of stay at the place of residence was used as the weight).
- **Covariates:** Age, sex, ethnicity, body mass index (BMI), smoking status, alcohol consumption, sunscreen use, oily fish intake, vitamin D supplementation, moderate and vigorous physical activity and socioeconomic deprivation.
- Exclusion: Participants from a non-UK birthplace.

Analyses

- Weighted ambient UVB was divided into five quintiles where lower values imply lower UVB exposure and higher values indicate higher UVB exposure. A frequency table and associated percentages were created to compare the characteristics between the included and missing participants.
- Descriptive statistics to compare the characteristics of exposure and outcome variables.
- Using univariable logistic regression analysis, factors associated with outcome variables were determined as well as a p-value <0.25 was included in the multivariate model.
- The final model was built using the backward elimination method, containing the only variables whose p-value remained ≤ 0.05.

Results

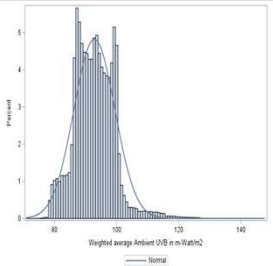

Figure 1: Distribution of weighted average ambient UVB.

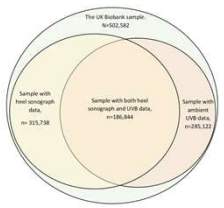

Figure 2: Venn diagram of the sample selection.

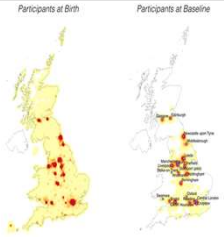

Figure 3: Heat map of residential Location

Table1:Frequency table showing the comparison between the characteristics of the participants.

Variable, Categories	Sample with both UV and heel sonograph data n=186,844		All other Biobank participants n=315,738	
	Frequency	Percentage	Frequency	Percentage
Age (years)				
<45	18,487	9.9	33,391	10.6
45 to 54	53,041	28.4	89,358	28.3
55 to 64	80,134	42.9	132,164	41.9
≥65	35,182	18.8	60,825	19.3
Sex				
Female	101,268	54.2	172,114	54.5
Male	85,576	45.8	143,546	45.5
Missing			78	0.0
Ethnicity				
White	2,258	1.2	26,653	8.4
Non-white	184586	98.8	288,109	91.2
Missing			976	0.3
BMI				
Underweight	1,205	0.6	4,604	1.5
Average	58,198	31.1	99,227	31.4
Overweight	78,978	42.3	130,252	41.3
Obese	45,477	24.3	76,770	24.3
Missing	2,986	1.6	4,885	1.5
Smoking				
Never	101,240	54.2	172,282	54.6
Previous	65,210	34.9	107,846	34.2
Current	19,739	10.6	33,239	10.5
Missing	655	0.4	2,371	0.8
Alcohol Intake				
Daily	38,607	20.7	63,162	20.0
1-4 times a week	94,765	50.7	149,965	47.5
1-3 times a month/occasionally/ never	53,325	28.5	101,179	32.0
Missing	147	0.1	1,432	0.5
Deprivation Quintiles				
Least	42,444	22.7	57,917	18.3
2nd	38,909	20.8	61,486	19.5
3rd	37,658	20.2	62,712	19.9
4th	34,604	18.5	65,775	20.8
Most	33,042	17.7	67,334	21.3
Missing	187	0.1	514	0.2

Table 2: Osteoporosis: prevalence and unadjusted and adjusted odds ratio (95% confidence interval).

	Osteoporosis Prevalence (%)	Multivariable Model OR	95% CI	p-value
Quintiles of ambient solar radiation				
Lowest	1.37	0.97	[0.86-1.10]	0.655
Q2	1.39	0.96	[0.85-1.09]	0.559
Q3	1.40	0.97	[0.86-1.10]	0.612
Q4	1.40	0.98	[0.87-1.11]	0.802
Highest	1.41	1.00		
Missing	1.43	0.98	[0.89-1.09]	0.753
Age in years				
<45 years	0.55	1.00		
45-54 years	0.82	1.53	[1.30-1.81]	0.000
55-64 years	1.55	3.05	[2.61-3.55]	0.000
≥65 years	2.48	5.05	[4.31-5.91]	0.000
Sex				
Female	1.68	1.52	[1.42-1.62]	0.000
Male	1.09	1.00		
BMI				
Underweight	9.88	4.54	[3.90-5.30]	0.000
Normal	1.82	1.00		
Overweight	1.04	0.55	[0.52-0.59]	0.000
Obese	1.31	0.64	[0.59-0.69]	0.000
Missing	1.09	0.59	[0.45-0.77]	0.000
Smoking status				
Never	1.54	1.00		
Previous	1.16	1.11	[1.04-1.19]	0.002
Current	1.74	1.73	[1.59-1.89]	0.000
Missing	2.34	1.15	[0.75-1.77]	0.519

Discussion and conclusion

- Average ambient UVB exposure across a lifetime was not associated with osteoporosis in older age.
- A limitation of this study is the large proportion of missing values for UVB exposure (Figure 2). Nevertheless, the similarity between the sample with UVB exposure measures and other Biobank participants reassured that the findings of this study might represent all participants (Table 1).
- Estimating lifetime UVB based on a maximum of two residential locations is another limitation of the analysis.
- Finally, most participants were comparatively healthy compared with the general UK population, which would lead to 'healthy volunteer' selection bias. However, due to its large and heterogenic sample size, the cohort is considered suitable for studying associations rather than the prevalence [3].
- The primary strength of the study is the large sample size. No other research has been conducted to determine the relationship between lifetime UVB and osteoporosis in such a large cohort.
- If the UVB exposure measures were able to allocate to the remaining Biobank sample in the future, the study could be replicated to test the validity of my findings.

References

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