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## Associations between vitamin K status and skeletal and cardio-metabolic health indices in 18–64-year-old Irish adults

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A high proportion of Irish men and women have mean daily vitamin K intakes which are likely inadequate. For example, we had previously shown that 52 % of a nationally representative sample of the adult Irish population from 1997–1999<sup>(1)</sup> had vitamin K<sub>1</sub> intakes below the UK recommended 1 µg/kg body weight<sup>(2)</sup>, and 17 % and 27 % of men and women, respectively, met the current US adequate intakes for vitamin K.<sup>(3)</sup> This may have consequences for vitamin K status and associated skeletal and non-skeletal health effects. This analysis explored associations between biochemical measures of vitamin K status and a biomarker of bone turnover and with a metabolic syndrome (MetS) risk score, and its component risk factors as defined by the International Diabetes Federation<sup>(4)</sup>. Data [dietary, lifestyle and risk factor] and serum were accessed from the most recent nationally representative sample of Irish adults (National Adult Nutrition Survey 2008–2010) ([www.iuna.net](http://www.iuna.net)). Vitamin K status measures (undercarboxylated osteocalcin [GLU], carboxylated osteocalcin [GLA], and % osteocalcin undercarboxylated [%ucOC]) and carboxy-terminal collagen cross-links (CTx; bone resorption marker) were measured in 692 adults by immunoassay.

Outcome variable	Unadjusted regression model <i>Association with %ucOC (β [95 % CI]; P value)</i>	Adjusted regression model
<i>Skeletal</i>		
Serum CTx	Positively associated (0.194 [0.002; 0.003]; < 0.001) (0.153 [0.001; 0.003]; < 0.001*)	
<i>Cardio-metabolic health</i>		
Central obesity [WC] (cm)	Inversely associated (−0.137 [−0.014; −0.02]; < 0.01)	NS**
Serum glucose (mmol/L)	Weakly associated (−0.069 [−0.01; 0.01]; 0.07)	NS**
Systolic [SBP] & Diastolic [DBP] (mmHg)	SBP weakly associated (−0.07 [−0.15; 0.005]; 0.06)	NS**
DBP inverse association (−0.099 [−0.29; −0.04]; 0.009)	NS**	
Blood lipids (mmol/L)	Total, LDL and HDL-cholesterol and triglycerides NS	NS**

\*Adjustment for age, sex, serum 25(OH)D, dietary calcium, smoking, HRT/oral contraception, PTH, BMI, total osteocalcin

\*\*Adjustment for age, sex, smoking and vitamin K intake. NS, non-significant association ( $P > 0.05$ )

Serum %ucOC was a significant ( $P < 0.0001$ ) positive determinant of serum CTx, adjusting for confounders (model explained 48 % variability in serum CTx). Associations with MetS risk factors were driven by age. Surprisingly, in younger adults (<50y), serum %ucOC was significantly ( $P < 0.05$ ) lower [Median (IQR)38.8 (27.5, 52.5) %] in those with central obesity and an additional MetS risk compared to those with no MetS risk[42.5 (30.4, 59.6) %], accounting for sex, smoking and vitamin K intake.

The pathogenesis for MetS and each of its components is complex and poorly understood. In addition to its role in skeletal health, vitamin K status may influence specific cardio-metabolic risk factors, however, further investigation is warranted to establish a causal relationship.

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