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**Background:** Low blood concentrations of serum 25-hydroxyvitamin D (s-25(OH)D) are common during winter months. Using twin and family-based studies, genome wide association studies and candidate gene studies, it has been shown that genetic factors may influence s-25(OH)D concentrations considerably. Thus, genetic factors may help to identify who is most at risk of developing low vitamin D status.

**Methods:** We used data from the VitMaD study, a double-blinded, randomized placebo-controlled intervention trial with healthy Danish families (n = 782). Participants were allocated to either vitamin D3-fortified bread and milk or non-fortified placebo bread and milk during a 6-month winter period in Denmark. The participants were genotyped for 25 SNPs in the vitamin D pathway and two common single nucleotide polymorphisms (SNPs) in the CYP2R1 gene (rs10741657 and rs10766197) and two common SNPs in the GC gene (rs4588 and rs842999) were found to predict baseline s-25(OH)D levels. S-25(OH)D concentrations before and after intervention was measured by LC-MS/MS. We estimated total vitamin D intake as the sum of dietary vitamin D, usage of multivitamin and vitamin D supplementation and intake of vitamin D3-fortified bread and milk for the fortification group. Genetic risk score (GRS) was calculated as the sum of number of risk alleles for CYP2R1 gene (rs10741657 and rs10766197) and GC gene (rs4588 and rs842999).

**Results:** At the end of the winter season we found that CYP2R1 (rs10741657) and GC (rs4588 and rs842999) were statistically associated with serum 25(OH)D concentrations and CYP2R1 (rs10766197) was borderline significant (p = 0.0599) for the fortification group. No association was found for the control group and hence no difference in mean s-25(OH)D concentrations and carrying 0 to 8 risk alleles (p = 0.1428) of CYP2R1 gene (rs10741657 and rs10766197) and GC gene (rs4588 and rs842999) were observed for the control group. For the fortification group, there was a negative linear trend for s-25(OH)D concentrations and carrying 0 to 8 risk alleles (p=0.0001). We found a significant positive linear relationship between carrying 0–2, 3, 4 or 5 risk alleles, total vitamin D intake and the increase in s-25(OH)D concentrations (p = 0.0012, 0.0001, 0.0118 and 0.0029), respectively. For participants carrying 6–8 risk alleles there was no association (p = 0.1051). Adequate s-25(OH)D concentrations were achieved for more participants carrying a low GRS compared to participants carrying a higher GRS.

**Conclusions:** At the end of a winter season, there was an association between genetic variation in CYP2R1 and GC genes and s-25(OH)D concentration for the fortification group but not for the control group. Carriers of a high GRS of CYP2R1 (rs10741657 and rs10766197) and GC (rs4588 and rs842999) were more prone to be vitamin D insufficient compared to carriers of low GRS. Carriers of a high GRS may need a higher amount of vitamin D supplementation to achieve adequate s-25(OH)D concentrations. Importantly, it is seemed that low risk carriers with adequate s-25(OH)D concentrations achieved even higher s-25(OH)D concentrations with increasing vitamin D intake whereas high risk carriers did not. In the future, genetic factors might be taken into account when recommending vitamin D supplementation or food fortification.

#02 Day 1

The nutritional impact of replacing cows’ milk with a vitamin D fortified growing-up milk, in the diets of young UK children

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**Background:** The Reference Nutrient Intake (RNI) of young children between the ages of 1 to 5 years is 7μg/day (1). The most recent UK National Diet and Nutrition Survey (NDNS) showed that the average UK toddler is gets 27% of their daily dietary intake of vitamin D (2). This has spurred discussion on the best way to improve the vitamin D status of children. A universal approach to vitamin D supplementation has recently been suggested by the Chief Medical Officer (3), but targeted supplementation strategies have had limited success (4), which questions the cost effectiveness of this approach.

Canada has mandatory fortification of vitamin D to cow’s milk. Maguire and colleagues showed that most Canadian children could maintain their vitamin D status by consuming vitamin D fortified milk (5), suggesting this could be a more effective way of increasing and maintaining children’s vitamin D status. In the UK cows’ milk contains trace amounts of vitamin D whilst growing-up milk (GUM) contains 1.7μg/100ml. This simulation study aimed to assess the impact of replacing non fortified cow’s milk with vitamin D fortified GUM in the diets of young UK children.

**Methods:** Analyses were based on individual dietary data from NDNS, 2008–2011. Children consuming cows’ milk only and aged 18–36 months (n=159) were divided into 2 subgroups, 18–23 months (n=41) and 24–36 months (n=118). Simulations were conducted using Creme Food® software and cow’s milk was replaced with GUM in individual diets, either at observed consumption (scenario 1) or an intake of 300mL/d (scenario 2). Nutritional intakes from the observed data and after simulations were compared and evaluated against UK nutrient recommendations.

**Results:** in both scenarios and subgroups, replacing cows’ milk with GUM led to a significant increase in vitamin D intakes (+278 to +356%). Mean intakes of vitamin D were 1.8±0.28μg/d (mean±SEM) for cows’ milk consumers aged 18–24m, and 17±1.05μg/d for cows’ milk consumers aged 24–36m. This corresponds to 4.1% of the 18–24m having intakes of vitamin D at or above the RNI, and 2.8% of the 24–36m. After replacement from cows’ milk by GUM at observed consumption (scenario 1), mean intakes respectively corresponded to 48.1% and 43.0% of the children having intakes of vitamin D at or above the RNI.
For scenario 2, 24.1% of 18-24m children & 23.6% of 24-36m children had intakes at or above the RNI level.

**Conclusion:** The role of vitamin D fortified foods in the UK, especially in young children, could be a useful mechanism for increasing the nutritional intake of this essential nutrient. From this simulation we conclude that a daily consumption of 300ml fortified GUM can help increase nutritional intakes of vitamin D in young UK children.


**#03, Day 1**

Cross-sectional study on different characteristics of physical activity as determinants of vitamin D status; inadequate in half of the population

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**Background:** Physical activity (PA) may have an impact on vitamin D status. The aim of the present study is to assess the contribution of different characteristics of PA (duration, intensity as estimated by energy expenditure, location) to vitamin D status.

**Methods:** The study was conducted in 1255 community-dwelling older men and women of the Longitudinal Aging Study Amsterdam (LASA). Cross-sectional relationships between PA and serum 25-hydroxyvitamin D (25(OH)D) concentrations were examined.

**Results:** Total PA, both indoor and outdoor PA, expressed in kcal/d was positively associated with 25(OH)D in women (P<0.05) but not in men. The total time spent on these activities was not associated. As compared with the lowest tertile, both men and women in the highest tertile of cycling activity (>6.4 min/d or 34.7 kcal/d) had a ~6 nmo/l higher 25(OH)D (P<0.05). For men and women in the highest tertile of gardening (>8.6 min/d or 87.6 kcal/d), these levels were 14.2 nmo/l (P<0.001) and 5.8 nmo/l 25(OH)D (P<0.05), respectively. Walking showed no association.

**Conclusions:** Daily time spent on total PA is often included when studying the association between sum of PA and 25(OH)D, while our study showed that energy expenditure might be a better unit. Individual types of outdoor PA with a high intensity, such as gardening and cycling, were associated with 25(OH)D.

**#04, Day 1**

A systematic review and meta-analysis of the effect of vitamin D in pregnancy on offspring health outcomes

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**Background:** We performed a systematic review to explore whether 1) low maternal circulating 25(OH)-vitamin D [25(OH)D] during pregnancy is associated with impairment of offspring health; and 2) maternal supplementation with vitamin D in pregnancy might ameliorate these effects.

**Methods:** Major electronic databases were searched up to June 2012 covering both published and grey literature. Bibliographies of selected papers were hand-searched for additional references. Relevant authors were contacted for any unpublished findings and additional data if necessary. All reviews, data extraction and quality assessments were performed by two reviewers according to CRD guidelines. Eligible studies included pregnant women and their offspring, and one or more relevant exposures (either assessment of vitamin D status [dietary intake, sunlight exposure, circulating 25(OH)D] or supplementation of participants with vitamin D or vitamin D containing food e.g. oily fish) and outcomes (offspring birth weight, birth length, head circumference, bone mass, anthropometry and body composition, risk of asthma and atopy, small for gestational dates, preterm birth, type 1 diabetes, low birth weight, serum calcium concentration, blood pressure and rickets). Maternal health outcomes were also addressed.

**Results:** 76 studies were included. There was considerable heterogeneity between the studies and for most outcomes there was conflicting evidence. Indeed, no convincing evidence was found for any association between maternal vitamin D status and offspring asthma, atopy, type 1 diabetes or blood pressure. However, modest positive relationships were identified between maternal 25(OH)D and 1) offspring cord blood or postnatal calcium concentrations (meta-analysis of 6 intervention studies, mean difference 0.05mmol/l [95% CI 0.02, 0.05]; studies all had high risk of bias); 2) offspring birth weight (meta-analysis of 3 observational studies using log-transformed 25(OH)D concentrations, pooled regression coefficient adjusting for potential confounding factors 0.63g/10% change in maternal 25(OH)D [95% CI 1.11,10.16], but no association in 4 studies using natural units, or across intervention studies); and 3) offspring bone mass (in observational studies judged to be of good quality, but which did not permit meta-analysis).

**Conclusions:** There was modest evidence to support associations between maternal 25(OH)-vitamin D status...
and offspring serum calcium concentrations, birth weight and bone mass. However, these findings were limited by their observational nature or risk of bias. High-quality intervention studies to investigate these outcomes are now required, as the current evidence base cannot adequately inform clinical practice.

Acknowledgements:
The UK Vitamin D in Pregnancy Working Group

#06, Day 1
Increased Vitamin D Supplementation Recommended during Summer Season in the Gulf Region: A Counterintuitive Seasonal Effect in Vitamin D Levels in Adult, Overweight and Obese Middle-eastern Residents

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Background: Seasonal variations in circulating vitamin D levels provide vital information as to the most appropriate time to either start or increase vitamin D supplementation in order to maintain optimal vitamin D levels. In this follow-up study we determined seasonal differences in serum 25(OH)D vitamin D levels, as well as parallel changes in metabolic parameters, in a cohort of adult overweight and obese Saudis.

Methods: 121 adult, overweight and obese, consenting Saudis aged 18–70 years old were randomly recruited from 4 Primary Health Care Centers in Riyadh. They were divided according to the season when baseline measurements were made (74 Summer [April–October]; 47 Winter [November–March]). Anthropometrics were performed and fasting blood samples were taken at baseline and every 3 months for 1 year. Fasting blood glucose, corrected calcium and lipid profiles were measured routinely. Serum 25(OH)D was quantified using a specific enzyme-linked immunosorbent assay (ELISA).

Results: Age- and BMI-matched mean 25(OH)D vitamin D levels from the winter group were significantly higher than those of the summer group (p < 0.001). In both groups, HDL-C levels improved significantly as 25(OH)D vitamin D levels increased with subsequent follow-ups, even after adjusting for age, gender and BMI (p < 0.001).

Conclusion: Seasonal differences in serum 25(OH)D vitamin D levels in Saudi Arabia are counterintuitive, with circulating levels being higher during the winter rather than the summer season. Increased vitamin D supplementation is thus recommended to maintain optimal serum 25(OH) vitamin D levels during the summer season.

#07, Day 1
Age and Milk Consumption Are Associated with Vitamin D Status in Pre-menopausal Saudi Women

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Background: There is little evidence published on prevalence of vitamin D deficiency among Saudi women, in spite of the widespread food fortification and the excellent opportunity of available sun light all over the year. The present cross-sectional study aims to determine the prevalence and risk factors of vitamin D deficiency among premenopausal women visiting commercial centers in Riyadh City.

Methods: A quasi–random technique was employed in the recruitment of subjects from various commercial Malls in Riyadh last May–November, 2012. A total of 256 subjects filled a general questionnaire, height and weight were measured and blood extracted ascertaining total 25-hydroxyvitamin D, calcium, phosphorous and alkaline phosphatase from a vitamin D External Quality Assessment (DEQAS)-certified laboratory.

Results: Vitamin D deficiency (< 50 nmol/L) was noted in 200 (77.6%) of subjects. Age and milk consumption were the significant predictors of vitamin D status, with 33.9% of variance perceived (p < 0.001). Increased BMI, being married and the presence of muscle pain were all significantly associated with vitamin D deficiency.

Conclusion: Nearly 4 out of 5 premenopausal Saudi women shoppers harbor vitamin D deficiency and this is influenced not by sun exposure, but by age and milk consumption. It is clear that general female public faces an imminent threat of vitamin D deficiency-related diseases unless aggressive public awareness is conducted.

#08, Day 1
A systematic review of the impact on vitamin D status with moderate levels of vitamin D intakes (5 mcg–20 mcg)

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Background: There is controversy surrounding the desig
tion of vitamin D adequacy as defined by circulating levels of the metabolite 25-hydroxyvitamin D [25(OH)D]. Depending on the cutoff chosen, dietary intakes of vitamin D may or may not provide sufficient impact upon vitamin D status, in improving levels of 25(OH)D. Purpose: We sought to examine whether a supplemental dose of 10 mcg (400 IU) as found in fortified foods or as a supplement, has a measurable impact on vitamin D status, as defined by improving status from below to above 50 nmol/L, or from less than 30 nmol/L to above 30 nmol/L.

Methods: Published literature was searched for relevant articles of 10 mcg (400 IU) vitamin D supplementation or fortification. Exclusion criteria were: nonhuman studies; cell, animal; review articles; studies lacking blood level data pre- and post-treatment; no control group; bolus treatments (weekly, monthly, yearly); vitamin D < 5 mcg (200 IU) or >20 mcg (800 IU); baseline 25(OH)D > 75 nmol/L; patient studies (e.g., diabetes, cancer, CVD); studies < 2 months; age < 19 years. Of the 123 studies retrieved, 24 were initially selected: 7 food studies with doses 3.3 to 20 mcg and 17 publications on supplements 5 to 20 mcg. Of these 7 studies provided 10 mcg (400 IU) meeting all criteria.

Results: Studies involving addition of 10 mcg (400 IU) as fortified foods or supplements gave similar effects on 25(OH)D, so data were combined. After ≥ 2 mo intervention, mean 25(OH)D status rose either from “insufficient” (25–50 nmol/L) to “sufficient” (>50 nmol/L); or from “deficient” (<25 nmol/L) to “insufficient” (<25 but >50 nmol/L). These increases would not have been predicted using the rule of thumb of 1 mcg raises 25(OH)D by 1 nmol/L.

Conclusions: Our data suggest that an additional intake of 10 mcg (400 IU) can raise average 25(OH)D out of the insufficiency or deficiency range. This suggests fortification with moderate amounts of vitamin D may have positive effects on bone health of populations.

#09 Day 1
Knowledge of vitamin D on the postnatal wards– D-disastrous or D-lightful?

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Background: In the UK, over 50% of whites and 90% of South Asians have insufficient vitamin D levels. Vitamin D is essential for calcium homeostasis and deficiency is most likely during rapid growth periods, during pregnancy and while breastfeeding. Newborn status is largely determined by maternal status. Exclusively breastfed infants are at special risk as breastmilk may not meet requirements, especially after 6 months. There is wide variation in the content and availability of vitamin D supplements, and despite NICE guidelines on vitamin D supplementation implementation remains uncertain.

Methods: We conducted an audit to determine the level of information given to pregnant and breastfeeding women regarding vitamin D and to gauge the knowledge of midwifery and medical staff on postnatal wards. The audit was based on two standards: 1. Antenatal standard NICE 62- At booking women should be given information and advice on the importance of taking a 10 microgram vitamin D supplement per day during pregnancy and whilst breastfeeding. Health professionals should ensure that women at greatest risk of vitamin D deficiency are asked about vitamin D supplementation. 2. NICE public health guideline 11- All infants and young children aged 6 months to 5 years should take a daily supplement containing vitamin D. We surveyed 20 mothers and 15 health professionals on the postnatal wards. The staff were asked whether they knew why vitamin D is important, who should be offered vitamin D supplementation and at what dose. The patients were asked similar questions to ascertain their knowledge of vitamin D and the level of information they had been given, whether they were taking or plan to take supplements, whether any other young children in their family take supplements and their at-risk status.

Results: Postnatal mothers: Less than half the women surveyed were given information after vitamin D supplementation during pregnancy. Only 65% women took supplements during pregnancy. No-one had been given information and advice about vitamin D supplements whilst breastfeeding and only 20% breastfeeding mothers were planning to start supplements (all as part of Healthy start or pregnancy multivitamin). A further 10% said that they would if they knew the dose to take. Only 40% women could give a reason why vitamin D supplements were important– all of them had taken supplements. 15% (3/20) women surveyed said they had risk factors for vitamin D deficiency, but only 2 were specifically asked about vitamin D deficiency. None of their other children took supplements. Staff: Only 67% staff were able to answer why vitamin D was important. No one could correctly highlight all the at risk groups from a list provided. Only 7% knew which children should be offered supplementation. Only one-third of staff identified (from options given) the correct dose of vitamin D supplement for high-risk women.

Conclusions: Current practice is better at fulfilling antenatal than postnatal standards (although health visitors may partly fulfill this role after discharge) and there is much scope for improvement. Knowledge levels appear to correlate with use of vitamin D supplementation, suggesting that appropriate information provision is vital. Education for midwives and doctors must also be a priority as we have demonstrated significant knowledge gaps. We plan to provide an NHS Choices leaflet in the booking packs and provide training to staff before re-auditing.

#10 Day 1
Increased Food Allergy with Vitamin D: A Randomized, Double-blind, Placebo-controlled Trial

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Background: To elucidate whether maternal vitamin D supplementation during lactation improves infantile eczema and other subsequent allergic disorders, a randomized, double-blind, placebo-controlled trial was performed. Methods: Mothers (n=164) of infants with facial eczema at one-month checkup were randomly assigned to receive vitamin D3 supplements (n=82; 800 IU/day) or placebo (n=82) for 6 weeks from May 2009 to January 2011. The
primary outcome was infantile eczema quantified by Scoring Atopic Dermatitis (SCORAD) index at the three-month checkup, and the secondary outcomes were atopic dermatitis, food allergy, and wheeze diagnosed by doctors up to 2 years of age.

**Results:** There was no significant difference in SCORAD at 3-month checkup between two comparative groups. Doctor-diagnosed food allergy was significantly more common up to age 2 years in vitamin D group (10/39: 25.6%) than in placebo group (3/40: 7.5%; RR=3.42, 95% CI=1.02 to 11.77, P=0.030). Moreover, at least one secondary outcome was also significantly more common in vitamin D group (17/39: 43.6%) than in placebo group (7/40: 17.5%; RR=2.49, 95% CI=1.16 to 5.34, P=0.012).

**Conclusions:** These results suggest that vitamin D supplementation may not decrease the severity of infantile eczema at three months of age, but may rather increase the risk of later food allergy up to two years of age. Because a large number of subjects was lost to follow-up, further study is needed to confirm the findings.

#11, Day 1

**Prevalence of vitamin D deficiency and its related aspects: An observational study of vitamin D status in pregnant women and newborns in China**

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**Background:** There are little data about the status of vitamin D in pregnant women and their newborns in China, and we evaluated the vitamin D status in pregnant women and their newborns in the whole year among pregnant women in Wuxi city (North latitude 32°), Jiangsu province, China.

**Methods:** In 3278 pregnant women of childbearing age in the second trimester, the concentrations of serum 25-hydroxyvitamin D (25OHD) were measured, and its relationships with season, age and air temperature were analyzed. Meanwhile, the concentrations of serum 25OHD in 32 maternal infant pairs were measured at birth in the winter.

**Results:** ①The mean 25OHD of pregnant women is 38.0 ± 15.8 nmol/L (range:10.1~108.7 nmol/L). Vitamin D deficiency (defined as serum 25OHD <30 nmol/L) accounted for 40.1% of all pregnant women. Vitamin D inadequate (serum 25OHD of 30~50 nmol/L) accounted for 35.9% of all pregnant women, and only 24.0% of pregnant women were vitamin D sufficient. Moreover, in the winter, most (58.7%) of pregnant women were the deficiency of vitamin D, and only 7.5% of the pregnant women were adequate to vitamin D. Of the 32 newborns, all were deficient in vitamin D. ② Maternal vitamin D levels among different seasons were significant different (χ²=326.15, P=0.001), and the lowest level of vitamin D was in the winter, and the highest was in the summer. Among different age groups of pregnant women, vitamin D levels had significant difference (χ²=11.82, P=0.003). The vitamin D level in 30~35 age group of pregnant women (median: 36.2 nmol/L, range: 13.8~108.7 nmol/L) was higher than that in the 25~30 age group (median: 35.9 nmol/L, range: 10.4~89.8 nmol/L) and the 18~25 age group (median: 33.3 nmol/L, range: 10.1~85.2 nmol/L). ③The vitamin D status of pregnant women showed the same trend as the air temperature fluctuations, but its phase lagged behind about two months, reaching its highest value in September. Meanwhile, the vitamin D level was correlated with air temperature and its partial correlation coefficient was 0.306 (n=3278, P<0.001). ④ There was significant positive correlation between the concentration of 25OHD in cord blood and that in maternal blood (n=32, r=0.682, P<0.001).

**Conclusions:** Vitamin D deficiency is prevalent in pregnant women and their newborns, especially in winter and in young pregnant woman. And the vitamin D status in pregnant women is significantly influenced by air temperature which is related to the exposure of ultraviolet rays.

#12, Day 1

**National surveillance study of hypocalcaemic seizures secondary to vitamin D deficiency in children in the UK**

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**Background:** Reports suggest that vitamin D deficiency (VDD), and its clinical complications, have increased in prevalence among children in the UK. However, there is very limited epidemiological data available to quantify these concerns, existing studies being limited to single or multi-centre case series. This study provides the first national incidence estimates for a clinical manifestation of childhood VDD: hypocalcaemic seizures. We describe the characteristics and clinical outcomes of affected children.

**Methods:** Prospective 2-year national surveillance study across the UK and Ireland using the British Paediatric Surveillance Unit (BPSU) system. All Consultant Paediatricians were contacted monthly between September 2011 and September 2013. Case reporting criteria: any child <16 years of age with a suspected seizure in the presence of a serum corrected calcium <2.0 mmol/L and a serum 25-hydroxyvitamin D <50 nmol/L. Exclusion criteria: previous hypocalcaemic seizure or an underlying condition causing secondary VDD (e.g. renal & liver disease). A number of reports had no 25-OH-D level available (usually due to an insufficient sample). These were classified as ‘probable’ cases if they otherwise met the inclusion criteria and had at least one of the following: 1) high alkaline phosphatase, 2) high parathyroid hormone, 3) radiological features of rickets. BPSU reporting rates in 2012 averaged 93.3%. Population estimates from ONS (UK) and CSO (Republic of Ireland) were used to calculate incidence rates.

**Results:** Of 137 case notifications, 79 were confirmed cases, 10 probable cases, 32 reported in error or duplicates, 14 unconfirmed cases [details pending], and 2 lost to follow-up. 77 of the 89 confirmed and probable cases were infants (86.5%), with seven aged 1–2 years (7.9%) and five aged 11–15 years (5.6%). This equates to an incidence of 3.4 per million per year in children age 0–15 years, and 4.3 per 100,000 per year in infants. There was a male predominance of 82%. The majority of cases were from high-risk ethnic groups, with incidence estimates of 41.5 per 100,000 per year in Black infants and 37.4 per 100,000 per year in Asian infants. 61% had multiple seizures, and 20% had seizures lasting >10 minutes. 81% did not exhibit other clinical features of VDD, whilst 15% had clinical rickets. Median 25-OH-D = 11.2 nmol/L, ALP = 667 IU/L, PTH = 21.8 pmol/L, maternal 25-OH-D = 19 nmol/L. Mean serum calcium = 1.42 mmol/L. i.v. calcium gluconate was given in 45% and anti-convulsant medication in 26%, 48% did not receive any acute treatment. 12 cases (14%) received neither cholecalciferol nor ergocalciferol. Alfalcalfiol was prescribed in 14% of cases. Mean length of admission was 3.9 days. There were no deaths, and only one child had sequelae on discharge; an extravasation burn from i.v. calcium gluconate.
Conclusions: Hypocalcaemic seizures secondary to VDD are a rare, but preventable, cause of morbidity in UK children. We confirm previous reports that VDD presents with hypocalcaemic symptoms in infancy and adolescence. We report an unexpected male predominance in cases, and hypothesize that differences in skeletal growth could increase susceptibility to hypocalcaemia in boys. A minority of cases did not receive the recommended type or dose of vitamin D treatment, suggesting a need to improve paediatricians’ knowledge regarding VDD management. Further studies are needed to investigate the epidemiology of rickets more broadly.

#13, Day 1
Vitamin D status of children in rural and urban Ethiopia: predictors for deficiency

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Background: There are few studies that look at vitamin D status in children living in sunny climates as it is assumed that they receive adequate vitamin D from sun exposure. Purpose: To determine vitamin D status and its predictors among school children aged 11-18 years in Ethiopia.

Method: A school-based comparative cross-sectional study was conducted in Adama Town (urban, n = 89) and Adama Woreda (rural, n = 83) for a total sample of 174 during May–June, 2013. Children were randomly selected using multi-stage stratified sampling method. Socioeconomic, demographic, and sun exposure data were obtained; anthropometry measured; and capillary blood (finger prick) to determine serum 25(OH)D levels.

Results: Vitamin D deficiency (serum 25(OH)D <50 nmol/L) was found in 42% of children. The proportion of deficiency was significantly higher among urban students as compared to those in rural setting (61.8% vs 21.2%, respectively; p<0.001). The significant predictors of lower vitamin D status identified using multivariable logistic regression model were: urban setting, female sex, high maternal education, greater triceps skinfold thickness, less sun exposure, less body surface area exposed, having television/computer in the home, and high socioeconomic status [AOR(2.74–19.57): 95CI%[1.23, 69.21]].

Conclusion: Vitamin D deficiency was prevalent in school children living close to the equator in Ethiopia, both in urban and rural settings, with the prevalence being significantly higher among urban school children. Knowing that modernization is bringing about a change in vitamin D can inform policy-makers in Ethiopia and other tropical countries about the need to implement public health measures to prevent escalation of vitamin D deficiency and its associated health outcomes.

#15, Day 1
Validation of a vitamin D food frequency questionnaire using the method of triads

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Background: Food frequency questionnaires (FFQ) are often used in large epidemiology studies to assess the habitual intake of foods and/or specific nutrients of interest, with relative ease and minimal cost. Although humans obtain most of their vitamin D via the action of ultraviolet (UV)-B radiation on 7-dehydrocholesterol in the skin[2], this endogenous synthesis is limited by a number of factors, most notably latitude and season. In the UK and Ireland (at approximately 50°–60°N)[3], UV-B intensity is insufficient to synthesise vitamin D for 6 months of the year, spanning October–March. As other factors in today’s modern lifestyles (e.g. sunscreen/cosmetic use, indoor occupations, lack of outdoor activities) further limit such synthesis during the summer months, the general population is becoming increasingly reliant on dietary sources of vitamin D to maintain adequate vitamin D status[2]. The aim of this study was to validate a new FFQ to assess habitual dietary vitamin D intake, using the
Methods: A total of 49 apparently healthy adults (n=23 males; n=26 females) aged 18–65 years consented to take part in the current study, conducted between February and March 2013 to remove the confounding effect of sun exposure on circulating markers of vitamin D status. Dietary intakes of vitamin D were recorded using a 4–day weighed food record (WFR) and the newly developed FFQ. The FFQ was composed of 17 questions to document the habitual frequency of consumption and portion size of foods known to be sources of vitamin D (including natural sources, fortified foods and dietary supplements). Fasting serum 25-hydroxyvitamin D (25(OH)D) concentrations were quantified by liquid chromatography–tandem mass spectrometry (API 4000, AB SCIEX). The validity of the FFQ was established by applying the method of triads to the three intake measurements (FFQ, WFR and biomarker), which estimates the agreement between these three measurements and triangulates an estimate of true dietary intake.

Results: Dietary supplement use was reported by approximately one third of the group (n=17). The mean daily total vitamin D intake reported (food+supplements) using the FFQ was 8.04 μg [range 1.0–36.1 μg], and that from the WFR was 5.64 μg [range 0.4–31.7 μg]. Mean daily energy intake was 8466 kcal [range 4962–13807 kcal]. Reported vitamin D intakes, however, were similar between the sexes after adjusting for energy intake. Mean serum 25(OH)D concentration of the group was 45.3 nmol/l [range 12.9–279.0 nmol/l]. The mean difference between the vitamin D intake quantified from the WFR and FFQ equalling +1.62 (SD 3.86). Cross-classification analysis revealed >90% of the group were classified in the same or adjacent tertiles for vitamin D intakes when comparing results from the FFQ and WFR. Significant correlations were shown between the three intake measurements (FFQ and biomarker: rQR=0.61; WFR and biomarker: rQR=0.54; and, FFQ and WFR: rQR=0.90, all P<0.001). The overall validity coefficient (PQT) of the FFQ calculated using the method of triads was 0.59 (PQT = √rQR×rQR+rRR−rQR×rBR), indicating a high validity.

Conclusions: The vitamin D FFQ has now been validated for use in future studies interested in assessing habitual vitamin D intake within the general adult population.


#16, Day 1
Does prenatal exposure to vitamin D fortified margarine and milk alter birth weight? A societal experiment

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Background: Several studies have investigated the association between vitamin D in pregnancy and birth weight, but the conclusion of the studies are not clear. The present study examined if exposure to vitamin D from fortified margarine and milk during prenatal life influenced birth weight.

Methods: The project was based on the Danish vitamin D fortification programs (mandatory fortification of margarine 1961–1985 and voluntary fortification of low-fat milk 1972–1976). The influence of vitamin D exposure during prenatal life on birth weight was investigated among 59,411 Danish children by comparing birth weight among individuals born before, during, and after fortification. Children born around the periods of fortification were identified in the Copenhagen School Health Record Register in which information of birth weight were available for all school children in Copenhagen.

Results: Mean birth weight (95% CI) was lower among exposed than non-exposed children around all periods (Milk initiation: −20.3 g (−39.2 to −1.4), Milk termination: −25.9 g (−46.0 to −5.7)). Margarine termination: −45.7 g (−66.6 to −24.8)) except around the initiation period of margarine fortification, where exposed children were heavier than non-exposed children (Margarine initiation: 27.4 g (10.8 to 44.0)).

Conclusion: Exposure to vitamin D from fortified margarine and milk during prenatal life altered birth weight, but the associations were inconsistent. We speculate that the effect of vitamin D exposure in pregnancy is modified by the exposure prior to conception.

#17, Day 1
Congenital rickets due to vitamin D deficiency in the mothers

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Background: Recent reviews have suggested that vitamin D deficiency rickets cannot begin to occur before birth (1).

Methods: To explore this issue we have reviewed clinical reports of vitamin D deficiency in neonates from 1930 onwards. We found 25 cases with radiological and/or histological evidence of rickets identified within the first two weeks of life.

Results: Presentations of the infants included cranitottes, rachitotic rosaries, enlargement of wrists, tetany and convulsions. In two cases rickets had been suggested from ante-natal X-rays. In four cases histological examination of deciduous teeth showed clear abnormalities. In six cases spontaneous fractures occurred in the first month of life. Of the 16 infants with serum calcium assays 15 had values lower than 2.2 mmol/L. Of 13 infants with serum alkaline phosphatase assays 12 had abnormally high levels. All the seven infants with assays for serum 25-hydroxyvitamin D had values lower than 25 nmol/L. There was evidence of maternal deficiency in 24 cases and in 16 of these the diagnosis of the rickets in the infants led to the identification of symptomatic osteomalacia in the mothers.

Conclusions: It is important to recognise that overt bone disease can be present at and before birth as a result of maternal deficiency.

Fractures in rickets due to vitamin D deficiency

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Background: Older authors from at least 1906 onwards were clear that vitamin D deficiency rickets could cause fractures. In one recent study (1) the conclusion was that fractures in early childhood were unlikely to be caused by vitamin D deficiency.

Methods: To examine this view reports of fractures at less than two years of age in rickets due to vitamin D deficiency have been reviewed.

Results: 38 patients were identified in 21 publications between 1918 and 2011. Their ages ranged from birth to 23 months (median 5 months). There were at least 26 fractures of ribs, 13 of radii, 10 of femora, 10 of tibiae, 9 of ulnae, 6 of clavicles, 3 of fibulae, 2 of vertebrae and one of a humerus. There were multiple metaphyseal lesions, some of which could have represented true fractures. There was one skull fracture found soon after birth and many cases with skull abnormalities of uncertain nature. Most of the diaphyseal fractures were undisplaced, most were asymptomatic and most were apparently spontaneous. It was sometimes not possible to distinguish undisplaced transverse fractures from pseudofractures.

Conclusions: It is important to include vitamin D deficiency rickets in the differential diagnosis of fractures in young children.

Anaphylaxis admissions in Chile are strongly associated with higher latitude and lower solar radiation

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Results: 2316 anaphylaxis admissions were registered, with the following diagnoses: food–induced anaphylaxis in 230 cases (10%), drug–induced anaphylaxis in 208 cases (9%), and unspecified anaphylaxis in 1878 cases (81%). Median age of patients was 41 years and 53% were female. National anaphylaxis admission rate was 1.41 per 100,000 persons per year. We observed a strong north–south increasing gradient of anaphylaxis admissions (β 0.04, P<0.01), with increasing rates south of latitude 34°S. A significant association was also observed between solar radiation and anaphylaxis admissions (β -0.11, P<0.009). Latitude was associated with food–induced (β 0.05, P<0.02), but not drug–induced (β -0.02, P=0.27), anaphylaxis. The association between latitude and food–induced anaphylaxis was significant in children (β 0.01, P=0.006), but not adults (β 0.003, P=0.16). Anaphylaxis admissions were not associated with regional sociodemographic factors like poverty, rurality, educational level, or ethnicity.

Conclusions: Anaphylaxis admission rates in Chile are highest at higher latitudes and lower solar radiation, used as proxies of VD status. The associations appear driven by food–induced anaphylaxis. Our data support a possible role of VD deficiency as an etiological factor in the high anaphylaxis admission rates found in southern Chile.

Sun exposure, dietary intake, and nutritional supplement use among children with atopic dermatitis in Santiago, Chile

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Background: Low vitamin D (VD) status is common among patients with atopic dermatitis (AD) and some studies suggest an association between VD deficiency and increased AD severity. We hypothesized that lifestyle habits of patients with AD may adversely affect VD status.

Methods: We conducted a cross-sectional study of 68 children with AD, who were recruited from a large university–affiliated allergy and dermatology clinic in Santiago, Chile. Inclusion criteria included age younger than 18 years and AD as defined by Hanifin and Rajka. Exclusion criteria were known VD deficiency and disorders of VD metabolism. AD severity was assessed by Scoring Severity of AD (SCORAD) index. Patients’ parents were asked by survey about the patient’s AD characteristics and about several lifestyle–related factors that affect VD status, such as sun exposure, dietary intake and nutritional supplement use. Data analysis used descriptive statistics, t-test, and chi-square. A two–tailed P<0.05 was considered statistically significant.

Results: The mean age of the enrolled AD patients was 5.7±4.5 years and 53% were female. The mean SCORAD index was 34 ±19, with 34% classified as having mild AD.
44% moderate, and 22% severe. 62% reported allergic comorbidity. 35% allergic rhinitis, 25% asthma, and 19% food allergy. A history of skin infections was present in 55% of patients. Regarding seasonal variation of AD, 19% worsened in fall–winter, 35% worsened in spring–summer, and 44% said that they were not affected by seasons. 41% of parents considered that sun exposure worsened AD severity in their child, while only 12% of parents considered sun exposure improved their AD. Winter and summer seasonality of AD flares was significantly associated with parental belief about sun exposure improving or worsening AD severity, respectively (P = 0.001). 81% of patients used sunblock frequently or always in summer, and 19% used sunblock frequently or always during other seasons. Most patients (57%) performed no outdoor activities or less than 4 hours/week on a regular basis. Almost one-third of patients watched TV screen / computer / videogame more than 2 hours per day. Regarding dietary intake of VD, 9% of patients consumed VD–fortified milk formula, but only one patient (1.5%) had at least 400 IU VD intake daily in milk. Of children older than 1 year of age, 16% did not eat fish (a potentially good source of vitamin D) and 40% ate fish less than once per week. Only 8% of patients took multivitamin or vitamin D supplements daily. None of these VD–related factors (seasonality of AD, sun exposure, dietary intake or nutritional supplementation) were associated with SCORAD index (all P > 0.05).

Conclusions: Children with AD in Santiago, Chile appear to have little sun exposure and, in a significant proportion, a parental belief that sunlight worsens AD. In addition, a very low dietary intake of VD–rich and VD–fortified food was observed. Moreover, use of VD–containing nutritional supplements was rare. Low exposure to VD sources was not significantly associated with AD severity. Together, these lifestyle factors put these children with AD at increased risk for VD deficiency, a condition that potentially may worsen their AD severity. Upcoming work with this group of patients will include 25OHD testing, and a randomized, double-blind, placebo-controlled trial that will test the effect of weekly vitamin D supplementation on AD severity in children.

#21. Day 1
Adjusted Calcium concentration, Phosphate concentration, Alkaline Phosphatase activity and Parathyroid Hormone concentrations in Plasma are Not Useful in Predicting Vitamin D Status in Children
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Background: The incidence of both symptomatic and asymptomatic vitamin D deficiency is growing, especially among certain ethnic groups and those with particular dietary preferences. There are an increasing number of disorders thought to be linked to vitamin D deficiency. Several lifestyle factors, including shift work and mode of dress, have been identified as causes for vitamin D deficiency. Maternal deficiency has also been recognised as a risk factor for neonatal complications including hypocalcaemia and rickets. These studies have led to increased demand for measurement of blood concentrations of 25–hydroxyvitamin D (25OHD), but there are barriers to effective use of the vitamin D service: (i) limited laboratory capacity; and (ii) inappropriate test requesting. To ensure that test availability is matched to clinical need, the Paediatric Biochemistry Laboratory has historically assessed any abnormalities in other standard biochemical tests of bone health before a decision is made whether to refer a sample for 25OHD analysis. The aim of this retrospective survey was to assess the relationship between the analyses included in a bone chemistry profile and parathyroid hormone (PTH) with 25OHD status in an unselected paediatric population in order to determine which test might be the best predictor of 25OHD deficiency during routine assessment.

Methods: Requests made in 2 twelve month periods (2007 and 2010) were reviewed in the laboratory information management system and adjusted calcium, phosphate, alkaline phosphatase and PTH were recorded. The proportion of abnormal results for each marker was compared across 25OHD status defined as deficient (<25 nmol/L), insufficient (25.1–50nmol/L) or sufficient (>50nmol/L). Only results available before subjects started vitamin D replacement were included in the 2007 dataset but they were not excluded from the 2010 dataset.

Results: 130 and 1418 unique requests for the two time periods were identified, an almost 11-fold increase. The percentage of patients with 25OHD ≤50nmol/L fell from (70% in 2007 to 58% in 2010), perhaps as a result of including those who had started vitamin D replacement. A high proportion of 25OHD deficient patients had no abnormalities in bone biochemistry or PTH (40% in 2007 and 53% in 2010). At least one biochemical abnormality was observed in 50% (2007) and 23% (2010) of patients with sufficient 25OHD where results for all four markers were available.

Conclusions: PTH is the most likely marker to be outside the reference range (raised) if the patient is vitamin D deficient but the literature suggests the relationship between 25OHD and PTH may be complicated by glomerular filtration rate. Where abnormalities in routine biochemistry are identified, these may be monitored as an individual is treated. An absence of abnormal results, particularly in apparently asymptomatic subjects, will not exclude 25OHD deficiency.

#22. Day 1
The relationship between vitamin D status and parameters of muscle function and physical fitness in adolescents from the Young Hearts Study
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Background: Recent literature has highlighted skeletal muscle as a major target organ of the vitamin D endocrine system. Randomized controlled trials (RCTs) have shown that vitamin D supplementation can correct sarcopenia and muscle weakness in elderly populations (1). Adolescence is a critical period for skeletal-muscular development, however, few studies have investigated the effect of vitamin D status on muscle mass, strength and physical fitness in this age group (2, 3). Literature has reported a significant positive relationship between vitamin D status and aerobic fitness (VO2 max) in young adult populations (4). The aim of this study was to investigate the
association between vitamin D status and muscle strength, muscle power and VO2 max in adolescents.

**Methods:** The Young Hearts Study 2000 is a large cross-sectional study, which investigated a representative sample (n=2071) of 12 and 15 year old girls and boys from Northern Ireland between 1999 and 2001. A total of 1015 participants had serum 25-hydroxyvitamin D (25(OH)D) concentrations, the major biochemical indicator of vitamin D status, quantified using enzyme linked immunoassay (OCTEIA®, IDS, Ltd., UK). Total skinfolds (TS; mm) were determined by measurements taken at four sites and were used to calculate absolute fat free mass (FFM, kg) and FFM corrected for height (fat free mass index (FFMI); FFM kg/m2). Sargent jump test results were used to calculate peak power (W), using the Sayer’s Equation (5). Muscle strength was measured by hand grip dynamometry (Takei Scientific Instrument Company Limited, Japan) and VO2 max, a measure of physical fitness, was estimated from 20-metre shuttle test scores.

**Results:** Linear regression analyses were carried out in males (n=505) and females (n=510) separately to investigate any association between 25(OH)D concentration and a) TS, b) FFMI, c) muscle strength, d) muscle power and e) VO2 max. Vitamin D status was not associated with TS, FFMI or muscle power in either males or females. In males only, vitamin D was positively associated with muscle strength (β=0.062; p=0.012) and VO2 max (β=0.123; p=0.001), independent of FFMI, physical activity, pubertal status, season and protein intake adjusted for energy (g/m). The results of this study support the role of vitamin D status in muscular fitness in adolescent males.

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**#23, Day 1**

Seasonality of month of birth in TID patients exposed and unexposed to fortified with vitamin D food during gestation

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**Background:** Type 1 diabetes (TID) is one of the most common chronic diseases starting in childhood resulting from destruction of insulin-secreting beta cells. Incidence of type TID has been increasing during the past decades. The exact pathogenesis of TID remains unknown. Vitamin D was hypothesized to have a protective effect. Low vitamin D status is prevalent among industrialized populations. Status of pregnant women is of particular concern as low levels may have consequences for the health of the offspring. To date, the influence of vitamin D status during gestation on long-term risk of TID has not been widely studied. The main source of vitamin D is its synthesis in the skin due to exposure to sunlight. Oral intake augmented by fortification or supplementation is necessary in countries of high latitudes and seasonal variation in sunlight. In Denmark, therefore, national programs for food fortification with vitamin D are considered. The health benefits of such programs have not been studied. The phenomenon of seasonality of month of birth in TID was introduced by Rothwell et al. who found that more TID patients were born during the spring and early summer and fewer during the winter months. It was concluded that environmental influences during gestation stand behind the phenomenon. Later, geographical latitude with its influence on vitamin D synthesis was listed among the reasons. Thus, our study aimed to assess if intake of foods fortified with vitamin D during gestation had an effect on the risk of TID later in life. This sub-study tested the hypothesis that seasonality of month of birth in TID is more pronounced among individuals who were not exposed to vitamin D fortification during gestation.

**Methods:** From 1972 to 1976 fortification of low fat milk (2.5–3.8 µg/100g milk) in Denmark was permitted. Individuals born in two years after milk fortification start were considered as exposed to vitamin D fortification during gestation; individuals born in two years before milk fortification end were considered as unexposed. The civil registration numbers of all individuals born in Denmark in the exposure-related cohorts were received and their outcomes on TID diagnosis were obtained through the linkage to the Danish National Patient Registry. The analyses were conducted by Cox regression adjusted for linear time trend in TID, calculating TID hazards ratio for those born at a particular month vs. the rest of the year separately in the exposure-related cohorts. Statistical significance between the exposure-related cohorts was tested in the models for interaction between the exposure and a month of birth.

**Results:** There were no statistically significant differences in seasonality of month of birth in TID in individuals exposed or unexposed to vitamin D fortified milk during gestation. The differences between exposed and unexposed individuals were not statistically significant either.

**Conclusions:** To assess the impact of exposure to vitamin D during gestation for later TID risk we studied seasonality of month of birth in a specific context of food fortification practices in Denmark. We hypothesized that gestational exposure to milk fortified with vitamin D would attenuate seasonality of month of birth. Our hypothesis was not confirmed. Absence of the seasonality in the first place, non-mandatory milk fortification policy, and too low doses of fortified milk may partially explain our findings.

**#24, Day 1**

Genetic markers associated with plasma 25-dihydroxyvitamin D concentration in The Gambia, West Africa

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**Background:** Vitamin D is well known for its roles in promoting skeletal health and there is increasing evidence to suggest additional benefits of vitamin D on immunity and prevention of disease. Vitamin D status is conventionally determined by circulating 25-hydroxyvitamin D (25OHD). Genetic studies have highlighted the importance of polymorphisms within genes in the vitamin D pathway on circulating 25OHD concentration (vitamin D synthesis (NADSYN), transport (GC) and degradation (CYP24AI)). The aim of this study was to identify common variant genetic predictors of 25OHD concentration in The Gambia, West Africa using an 1) exome–wide and 2) candidate gene approach with a focus on vitamin D binding protein genotype (DBP).

**Methods:** Samples were collected as part of the MRC Keneba Biobank, The Gambia (n=1918). DNA samples were processed on the HumanExome BeadChip v1.1 (Illumina, USA), capturing putative functional genome–wide exonic variation. Genotypes were called using data–driven clustering and samples and markers with a call–rate >98% and a minor allele frequency (MAF) >5% were kept for analysis. 25OHD concentration had been previously measured on a subset of participants (DiaSo–rin, USA; monitored by DEOAS) and this subset (n=146) was included in this study. The median (IQR) age of participants was 10 (7) years, 42 were male and had no known disease. UNPHASED was used to determine the genetic predictors of 25OHD concentration as a continuous trait using two different approaches: including 1) all polymorphic markers (n = 31635) and 2) candidate gene markers (n = 9) from genes previously shown to be related to vitamin D metabolism (CYP24AI, GC, NADSYN). DBP genotype was based on two GC markers (rs7041, rs4588) and 25OHD concentration was compared between those with the Gc1–Ig genotype vs. those with the Gc1s–s1, Gc1f–Ig and Gc2–Ig genotype in accordance with their relative 25OHD binding affinities.

**Results:** The mean (SD) concentration of 25OHD was 61.5 (13.4) nmol/L and 25OHD concentration was not predicted by age (P = 0.2) or sex (P = 0.8). Using an exome–wide approach there were no significant associations with 25OHD concentration. Using a candidate gene approach rs7041 (GC, P = 0.02) and rs2296241 (CYP24AI, P = 0.04) were the only markers associated with 25OHD concentration. The DBP genotype distribution was Gc1f–f (71.9%), Gc1s–s1 (8.6%), Gc1s–Ig (5.1%) and Gc2–f (6.8%). 25OHD concentration was higher in those with the Gc1f–f genotype (n = 105) compared with those without (n = 41) (63.4 vs. 57.5 nmol/L, P = 0.02).

**Conclusions:** This is the first study to assess the genetic predictors of vitamin D status using Exome–Chip data. Future work will include measuring 25OHD concentration in the remaining participants and conducting gene and pathway analyses for rare variants analysis (MAF<5%). This study adds to the evidence that different DBP genotypes are associated with 25OHD concentration. Gc1f–f, known to have the highest affinity for 25OHD, had the highest 25OHD concentration compared with the lower affinity DBP genotypes. The difference in Gc1f–f frequency observed in this study in Gambians (72%) compared with literature values for Caucasians (6%) may have implications for the way in which total 25OHD concentration is interpreted across different ethnic groups.

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**#25, Day 1**

**Prenatal Vitamin-D levels and Adult Schizophrenia: Evidence from a Danish Societal Experiment**

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**Background:** Of late, the influence of prenatal nutrition on the long term health of progeny has received increased scrutiny. The Detcit project, aims to eliciting the role of prenatal vitamin-D levels on future health outcomes such as the development of schizophrenia amongst progeny later in life. The first step in the Detcit protocol is to study the potential association between prenatal vitamin-D levels and the development of adult schizophrenia by examining a societal experiment undertaken by the Danish government from 1961 to 1985. During this period, the Danish government mandated the fortification of margarine with vitamin-D, 1.25mg/100g. In this talk we will analyze and discuss the benefits associated with prenatal consumption of vitamin-D fortified foods in terms of the development of schizophrenia amongst the progeny later in life.

**Methods:** In order to assess the potential health effects of consuming vitamin-D fortified foods, we performed a registry based study, taking advantage of the extensive Danish public health registries. At birth, every Dane is assigned a CPR number and information pertaining to date of birth, current living status and gender is stored in the CPR registry. By linking the CPR registry with the National Psychiatric Research Register, we were able to collect information pertaining to every Dane born 2 years prior to and after each change in the Danish fortification policy between 1961 and 1985. Using Age–Period–Cohort models we examined the incidence rate of schizophrenia amongst the birth cohorts prior to and after termination of the fortification policy in 1985. Further subdividing the birth cohorts by month, we were able to examine differences in the incidence rates of schizophrenia by season of birth. This is of particular importance due to the seasonal dependence on dietary sources of vitamin-D in Denmark. To test the hypothesis of an association between the prenatal exposure to vitamin-D fortified foods and the risk of the progeny developing schizophrenia later in life, Cox regression models were fit. Cox regression models were also used to test the hypothesis of interactions between season of birth and exposure to vitamin-D fortified foods.

**Results:** The results of the Cox regression analysis indicated that there was a significant interaction between the season of birth and exposure to vitamin-D fortified margarine amongst children born between 1983 and 1987. Specifically, in regards to children born after the cessation of vitamin-D fortification, children born from May–July have an increased risk, [hazard ratio 1.40 [1.05,1.85]], of developing schizophrenia compared to children born between November and January. In contrast, there was no evidence to suggest a similar association amongst the children born while the vitamin-D fortification policy was in place.

**Conclusion:** The results of our study suggest that the vitamin-D fortification policy enacted in Denmark until June 1st, 1985 had a protective effect amongst children born during the spring in regards to later development of schizophrenia.
#26, Day 1
Vitamin D in the General Population of Young Adults with Autism in the Faroe Islands

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Background: Vitamin D deficiency has been proposed as a possible risk factor for developing autism spectrum disorder (ASD). Understanding gene–environment interaction in autism is currently a very important topic for research into early neurodevelopment. Given the genetic isolate character with specific environmental exposures, the Faroe Islands constitute an interesting environment in which to conduct epidemiological studies.

Methods: Design/Setting: 25-hydroxyvitamin D3 [25(OH)D3] levels were examined in a cross-sectional population-based study in the Faroe Islands. Effects of gender, age, month/season of birth, IQ, various subcategories of ASD and ADOS score were also investigated. Participants: The case group consisted of a total population cohort of 40 individuals with ASD (aged 15–24 years), and the control group included their 62 typically-developing siblings, their 77 parents, and 40 healthy age and gender matched comparisons.

Results: The ASD group had significantly lower 25(OH)D3 levels (24.8 nmol/L) than healthy comparisons (37.6 nmol/L, p = 0.002), and also lower than their siblings (42.6 nmol/L, p < 0.001) and parents (44.9 nmol/L, p < 0.001). Parents had the highest levels. Males in the ASD (p = 0.12) and sibling (p = 0.03) groups had lower 25(OH)D3 levels than females. There was no association between vitamin D and age, month/season of birth, IQ, subcategories of ASD, or ADOS score. Among the ASD group, 60% were severely deficient (<30 nmol/L) and 84.2% of the whole study sample (n=219) had deficient/insufficient levels (<50/75 nmol/L).

Conclusions: The present study, demonstrating a association between low levels of 25(OH)D3 and ASD, is the first to be based in a total population and to use siblings, parents and general population control groups. It adds to similar findings from other regions of the world, indicating vitamin D deficiency in the population and especially in individuals with ASD. As all groups were exposed to low levels of sunlight, the very low 25(OH)D3 in the ASD group suggests that some other underlying pathogenic mechanism may be involved. An important next step will be to replicate these findings in larger samples, possibly requiring international collaboration.

#27, Day 1
Vitamin D supplementation during pregnancy and infancy reduces primary care antibiotic use for acute illnesses during infancy

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Background: Antibiotic prescribing in primary care is one of the most important drivers of antibiotic resistance. Strategies to reduce antibiotic prescribing are a current focus of health care quality improvement. We aimed to determine whether vitamin supplementation during pregnancy and infancy reduces antibiotic prescribing for acute illnesses during infancy.

Methods: We performed a randomised, double-blind, placebo-controlled trial in Auckland, New Zealand (latitude 36oS). Pregnant mothers, from enrolment at 27 weeks gestation to birth, and then their infants, from birth to age 6 months, were assigned to receive placebo or one of two dosages of daily oral vitamin D3. The enrolled woman/infant pairs were randomised to: placebo/placebo, 1000IU/400IU, or 2000IU/800IU. Serum 25-hydroxyvitamin D [25(OH)D] concentration was measured at enrolment, 36 weeks gestation, on cord blood samples, and at 2, 4 and 6 months of age. We audited the primary care records of enrolled infants to a median age of 18 months, identified all acute visits and determined whether oral antibiotics were prescribed at each visit. Study investigators, parents and all treating physicians remained blinded to group allocation until after completion of the primary care audit.

Results: 260 pregnant women were randomised to placebo (n=87), lower dose (n=87) or higher dose (n=86) vitamin D. In comparison with placebo, serum 25(OH)D concentrations were higher during pregnancy and infancy in both the lower and higher dose vitamin D groups. During infancy, mean serum 25(OH)D was greater in the higher than the lower dose group at 2, 4 and 6 months of age.1 Primary care data, collected to a median (25th-75th centile) age of 18 (14 to 21) months, were available on 238 (92%) of the children. At least one acute primary care visit was made by 232 (98%) of the children with the median (25th, 75th centile) number of acute visits being 8 (4, 13). Vitamin D supplementation did not affect the proportion making any acute visits (placebo 98%, lower dose 100%, higher dose 95%, p = 0.12), nor the median number of acute visits (placebo 8, lower dose 8, higher dose 8, p = 0.43). In comparison with placebo, the proportion of children prescribed antibiotics at any acute primary care visit did not differ for the lower dose vitamin D group (85% vs. 77%, p = 0.24) but was smaller in the higher dose group (85% vs 71%, p = 0.04). The number of acute visits at which an antibiotic was prescribed did not differ between groups (placebo 2, lower dose 2, higher dose 3, p = 0.50).

Conclusions: Vitamin D supplementation at 2000 IU/day from 27 weeks gestation until birth and then at 800 IU/day from birth to age 6 months may reduce the proportion of children prescribed antibiotics at acute primary care.
visits during the first 18 months of life.


#29, Day 1
Prevalence of vitamin D deficiency in local adult females of Pakistan

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Background: Many epidemiological studies in recent years suggest that vitamin D is associated with a high risk of osteoporotic fractures, malignancy of breast, colon, prostate and many respiratory diseases. As sun is a rich source of vitamin D so once it was thought that vitamin D deficiency is rare in Asia. But many studies in India proved vitamin D deficiency in healthy subjects. Then later some researchers in Pakistan also reported vitamin D deficiency in some regions of Pakistan. This study was aimed to investigate the prevalence of vitamin D deficiency in adult female of local population in Pakistan and to find out social and genetic factors that may contribute in hypovitaminosis.

Method: For the above said purpose blood samples from the local population has been collected, before sample collection a detailed interview was done to ask about their life style particularly about sun exposure. Renal and liver function test was done for screening any pseudo cause of hypovitaminosis. Serum Calcium and Phosphorus was done as a biomarker of vitamin D deficiency. Serum 25 hydroxy vitamin D estimation was done by EIA method.

Results: It has been observed that in adult female of Pakistan most of them have vitamin D insufficiency and some of them were deficient while serum calcium is not a significant biomarker to check the level of vitamin D. In obese female vitamin D insufficiency is more than non obese. Life style is a more significant factor that contributes in vitamin D insufficiency even in a sun rich country like Pakistan.

Conclusion: Subjects that had vitamin D deficiency not showed any significant clinical sign of any disease so this situation of vitamin D deficiency could be ignore at early stage that may lead to some drastic health effects in later stages that may be other then bone disorders. Further we are working on VDR genotyping of these subjects.

#30, Day 1
Current vitamin D status of adults in Germany and its association with season, latitude, and other determinants

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Background: Previous studies based on national health survey data from 1998 have shown that serum 25-hydroxyvitamin D (25(OH)D) concentrations among adults in Germany were low (1). A main reason is the inadequate UVB radiation during fall and winter in northern latitudes, which limits the endogenous vitamin D production. The “German Health Interview and Examination Survey for Adults” (DEGS1) provides representative data to assess the current vitamin D status of adults in Germany according to latitude of residence and to identify additional determinants of vitamin D status.

Methods: DEGS1 is a comprehensive, nationwide health survey.
representative for the age group 18–79 years. It was conducted by the Robert Koch Institute from November 2008 to December 2011. Overall, 8,151 adults participated in DEGS1. The survey instruments comprised questionnaires (including a semi-quantitative food frequency questionnaire; FFQ), interviews, physical examinations, and measurements in blood samples. Information on use of vitamin D supplements and oral contraceptives was obtained in computer-assisted personal interviews. Data on physical activity, media consumption, socio-economic status, and marital status was collected by self-administered questionnaires. A vitamin D intake index was constructed from FFQ information. Appointment dates of the participants were used to categorize the season of examination; latitudes (47°–49°, 50°–51° and 52°–54°) were derived according to region of residence. Participants with valid serum 25(OH)D measurements were included in the analyses (3,694 women and 3,422 men). Mean serum 25(OH)D values were calculated by gender and according to season and latitude. Determinants of vitamin D status were analyzed in gender-specific multiple linear regression models. Results were weighted to improve the representativeness.

Results: The majority of German adults had serum 25(OH)D concentrations below 50 nmol/l (61.7%). A total of 21.7% had levels <25 nmol/l, while 11.8% had levels ≥75 nmol/l. Nearly all year round, people living in southern Germany had higher mean serum 25(OH)D levels than people living in other parts of the country. At latitudes 47°–49°, the mean 25(OH)D levels exceeded the threshold of 50 nmol/l in May to October (except August), at latitudes 50°–51° and 52°–54° from June to September. In multivariate analyses, summer season, lower latitude, higher vitamin D intake index, vitamin D supplement use, higher physical activity, lower BMI, and marital status were significantly associated with higher serum 25(OH)D levels in both sexes. Additional factors independently associated with higher 25(OH)D levels included younger age, use of oral contraceptives, and higher socio-economic status among women, and lower media consumption among men.

Conclusion: The results confirm that the majority of German residents 18–79 years have serum 25(OH)D values below a recommended threshold of 50 nmol/l, especially during less sunny months and at higher latitudes. The identified determinants of serum 25(OH)D may contribute to tailor evidence-based recommendations for optimizing vitamin D status to specific target groups.


#31, Day 1
Infant vitamin D status and its impact on allergy development: follow up in the German LINA cohort study

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Background: Within the LINA cohort study maternal as well as newborn vitamin D levels were shown to be positively associated with allergic sensitisation and food allergy development within the first two years of life. The aim of the present study was to follow up the study participants investigating whether the effect of vitamin D is restricted to the prenatal period or can also be seen in one or two year old infants independently from the maternal status during pregnancy.

Methods: In total, blood samples of 374 pregnant mothers, 378 newborns, 466 one year old and 304 two year old children from the LINa cohort study (Lifestyle and environmental factors and their Influence on Newborns Allergy risk) were available for serum 25(OH)D3 analyses. Information about allergic manifestations during the first 4 years of life as well as confounding factors were obtained from standardized questionnaires filled out by the parents during pregnancy and annually thereafter. Serum IgE levels were analysed according to the same schedule.

Results: The median maternal serum 25(OH)D3 level during pregnancy was 22.19 ng/ml (interquartile range (IQR) 14.40–31.19 ng/ml), the median cord blood serum 25(OH)D3 10.95 ng/ml (IQR 6.99–17.39 ng/ml). The median serum 25(OH)D3 levels at year one and two were 33.20 ng/ml (IQR 28.20–39.10 ng/ml) and 22.25 ng/ml (IQR 16.9–28.30 ng/ml), respectively. A high correlation was seen between maternal and newborn 25(OH)D3 levels (R=0.812, p<0.001), both showing a significant seasonal distribution (p<0.050). A correlation was also seen when we compared 25(OH)D3 levels of one and two year old children (R=0.499, p<0.001). However, 25(OH)D3 levels at year one showed an independent trend, due to the general rickets prophylaxis within the first year (87% of the children were supplemented with vitamin D at least during the first 3 months), absolute 25(OH)D3 was generally higher with almost no variations due to seasonal sunlight exposure. In two year old children 25(OH)D3 levels had a similar seasonal pattern seen for pregnancy and cord blood. According to associations with allergic outcomes we could show comparable effects seen earlier within the LINa cohort: there was no evidence that vitamin D has allergy-protective effects. For wheezing, rather an association to higher 25(OH)D3 at year or year two was observed.

Conclusions: Our study demonstrates that in East Germany region (latitude: 51.3667) the vitamin D status of one year old children is sufficient due to a general rickets prophylaxis, whereas levels of two year old infants drop back to levels similar seen for pregnant mothers. However, according to allergic outcomes our data rather point to a promoting than a protecting effect of vitamin D.

#32, Day 1
Vitamin D levels in pregnant women in inner city Birmingham: a four year overview

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Background: Maternal 25–hydroxyvitamin D (25(OH)D) is important for many reasons especially as it determines the risk of neonatal hypocalcaemia and early rickets. Pregnant women deficient in 25(OH)D can adversely affect foetal and infant skeletal growth, bone ossification and tooth enamel formation. There is also emerging, although inconsistent, evidence that maternal 25(OH)D status could be associated with other foetal health outcomes such as birth weight, head circumference and risk of baby being small for gestational age. An adequate maternal status may be important for
proper foetal and placental development and proper immune response and function during pregnancy. Given its importance, we wanted to assess the 25(OH)D status of pregnant women in inner city Birmingham and to see if this was changing over time.

**Methods:** Aliquots of serum were taken from samples received in the laboratory for Downs testing (16–18 weeks gestation) during Autumn 2010–2013. Samples were analysed for 25-hydroxyvitamin D2 and 25-hydroxyvitamin D3 and results combined to give a total 250HD concentration. Samples were prepared using a liquid/liquid extraction and analysed on a Waters ACQUITY Ultra-Performance LC and Quattro Premier XE MS/MS. Patient age and ethnicity were recorded and results completely anonymised. Ethnicity was recorded as Caucasian, Asian, Black/African–Caribbean or other. 250HD status was defined as: Severely Deficient: <15nmol/L, Deficient: 15–30nmol/L, Insufficient: 30.1–50nmol/L, Adequate: >50nmol/L.

**Results:** In total 743 samples were analysed (2010 n=204, 2011 n=126, 2012 n=204 and 2013 n=209). Age and 250HD were not normally distributed in any of the years analysed and the proportion of people in the different ethnic categories was significantly different (combined data p=0.001). The distribution of age and ethnicity for the sample population did not change over the years (p=0.924 and p=0.397 respectively), however the proportion of people falling into the different 250HD status categories did significantly change over the years (p<0.001). In 2010, only 24% of the samples analysed were found to have adequate 250HD status. This rose to 51.2% in 2013. The distribution of 250HD concentration changed significantly over the years (p<0.001), with the median total 250HD rising from 31.5nmol/L in 2010 to 50.6nmol/L in 2013. The distribution of total 250HD concentration across the different ethnicities was also significantly different (p<0.001), with 59.6%, 30.1% and 31% of Caucasian, Asian and Black/African–Caribbean samples, respectively, being adequate.

**Conclusions:** Our data suggests that from 2010, the 250HD status of pregnant women is slowly improving, with 2013 being the first year that just over half of the samples tested showed an adequate status. This may link in with the increased availability or awareness of vitamin D supplementation through the Healthy Start scheme, launched in 2006, and other initiatives. In 2011 the Healthy Start supplements for pregnant women were made free of charge in Birmingham to all women, not just to those receiving benefits. Despite this, our data shows that an unacceptably high proportion of pregnant women in inner city Birmingham have a less than adequate 250HD status, especially those women from ethnic minorities. This raises the questions of whether enough pregnant women are taking supplements, or if they are taking the supplements, is the level of supplementation enough to increase their levels into the adequate status?

**#33, Day 1**
The role of geographical ecological studies in determining the role of vitamin D in disease risk and health outcomes

Grant WB

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**Background:** Since the publication of the ultraviolet B (UVB)-vitamin D-cancer hypothesis based on an ecological study of colon cancer mortality rates with respect to annual solar radiation doses in the United States in 1980 [Garland CF, Garland FC. Do sunlight and vitamin D reduce the likelihood of colon cancer? Int J Epidemiol. 1980;9:227–31], the approach has been extended to many types of cancer and various other health outcomes. However, not all health outcomes related to serum 25-hydroxyvitamin D [25(OH)D] levels have geographical variations related to geographical variations in solar UVB doses. However, some vitamin D-sensitive diseases have seasonal variations with highest rates in winter or spring. The question addressed in this study is: Which diseases have geographical variations in outcome related to solar UVB, which have seasonal variations, and why the difference?

**Methods:** The peer-reviewed literature was searched for diseases or health outcomes correlated with solar UVB doses and/or outdoor occupation and which have seasonal variations.

**Results:** The diseases related to geographical variations in solar UVB doses or outdoor occupation include anaphylaxis, autism, 15–20 types of cancer, Crohn’s disease, type 1 diabetes mellitus, multiple sclerosis, Parkinson’s disease, sarcoidosis, and sepsis. Those diseases or outcomes related to season include adverse pregnancy and birth outcomes, cardiovascular disease, Epstein–Barr virus diseases, falls and fractures, influenza and all-cause mortality rate. However, cold temperature is also a risk factor for seasonal diseases and outcome, making it difficult to separate the effects of solar UVB/vitamin D from those of temperature.

One reason for diseases falling in geographical or seasonal variation categories is the length of time it takes for the disease to develop. Some diseases, such as cancer, develop slowly so summertime solar UVB doses can raise serum 25(OH)D levels to where they can effectively combat the disease each year. Other diseases, such as influenza, myocardial infarction, and stroke, can develop rapidly when both long-term and short-term factors align.

**Conclusions:** Geographical ecological studies have provided strong support for the role of solar UVB doses in reducing the risk of several types of disease. When additional evidence on effects related to vitamin D from observational studies with respect to serum 25(OH)D level or personal UVB irradiance, the role of skin pigmentation, and laboratory studies of mechanisms, Hill’s criteria for causality in a biological system [Hill AB. The environment and disease. Association or causation? Proc R Soc Med. 1965;58:295–300] can be used to assess whether vitamin D is causally linked to reduced risk of the disease or adverse health outcome. While a few vitamin D randomized controlled trials have supported the ecological and observational studies, many were not designed and/or conducted properly [Heaney RP. Guidelines for optimizing design and analysis of clinical studies of nutrient effects. Nutr Rev. 2013 Dec 13; doi: 10.1111/nure.12090. [Epub]]. When they are, they, too, will add to the understanding of the role of vitamin D in reducing the risk of many types of disease and adverse health outcomes.

**#34, Day 1**
Effect of Cotinine Blood Serum Level on Vitamin-D Blood Serum Level Among Women Smokers in the United States.

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Background: The suffering from lung cancer as the disease becoming the usual cause of cancer mortality has been on the rise rapidly in the world since the 20th century. Results from epidemiological investigations have correlated cigarette smoking with the causation of lung cancer in the 1950s clearly. As we have taken the first step into the 21st century, the frequency of lung cancer has not only been dubious to decline, but the burden of the cancer has shifted from the developed to the less developed countries also. According to International Association of Cancer Registries (IACR), the lung cancer is accountable for 1.2 million new cases annually as well as responsible for 18% of all cancer death worldwide. The suffering from lung cancer as the disease becoming the usual cause of cancer mortality has been on the rise rapidly in the world since the 20th century. Results from epidemiological investigations have correlated cigarette smoking with the causation of lung cancer in the 1950s clearly. As we have taken the first step into the 21st century, the frequency of lung cancer has not only been dubious to decline, but the burden of the cancer has shifted from the developed to the less developed countries also. According to International Association of Cancer Registries (IACR), the lung cancer is accountable for 1.2 million new cases annually as well as responsible for 18% of all cancer death worldwide. The epidemiological data indicate that vitamin D deficiency is relatively common, at least in some parts of the United States and Europe, and that inadequate serum levels of the Vitamin-D are associated with an increased risk and poor prognosis of several types of cancer. Cigarette is the main metabolite of nicotine, and its serum or plasma level is a useful marker of tobacco smoking.

Methods: National Health and Nutrition Examination Survey (NHANES) datasets of Gender, Race, Cotinine and Vitamin D from the years 2001–02, 2003–04 and 2005–06 have been used for the purpose of epidemiology study for the relationship between Cotinine and Vitamin-D in women among different ethnicities in the United States.

Results: The data analysis from the NHANES 2001–02, 2003–04 and 2005–06 showed the Vitamin-D is lowest in active smoker women in whom the cotinine level is high, compared with non-smoker (low cotinine level) and passive-smoker (mid-range cotinine level) groups.

Conclusion: This data analysis has suggested us that race, gender and cotinine play an important factor on Vitamin-D level among women smokers, yet more research need to be done to explore more.

#36, Day 1
3-epi-25 hydroxyvitamin D in Pregnancy

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Background: Vitamin D deficiency has been reported during non-diabetic and Type 1 diabetes mellitus (TIDM) pregnancy(1). Both non-diabetic and TIDM neonatal (cord) 25OHD levels are significantly reduced in women classified as obese vs normal weight pre-pregnancy. In TIDM women, HbA1c at booking is significantly negatively correlated with maternal 25OHD, suggesting a potential role for this vitamin in maintaining glycaemic control (1). 25 OH2D/3 and 3-epi-25OH2D/3 share an identical structure (and molecular weight) and differ only in the stereochemistry of the hydroxy group at the C-3 position. The physiological importance of 3-epi-25OH2D/3 is uncertain and there have been limited studies determining the levels of these epimers in human populations. The aims of the current study were to, (1) determine 3-epi-25OH2D/3 levels throughout non-diabetic and TIDM pregnancy, (2) to examine the relationships between 25OH and 3-epi-25OH, (3) to assess the impact of maternal BMI on 3-epi-25OH and examine associations with markers of glycaemic control.

Methods: This was an observational study of 52 pregnant controls without diabetes and 65 pregnant women with TIDM in a university teaching hospital. Maternal serum 25OH and 3-epi-25OH were measured serially throughout pregnancy and post-delivery. 25OH and 3-epi-25OH were measured in cord blood obtained at delivery. 25OH and 3-epi-25OH were measured by liquid chromatography tandem mass spectrometry(LC–MS/MS).

Results: 3-epi–25OH was found in 90.2% of control (median 0.9 nmol/L; range 0.1–5.9 nmol/L), and in 94.5% of TIDM, women (median 1.4 nmol/L; range 0.1–10.5 nmol/L). In the control group, 3-epi–25OH at trimesters 1 and 2 significantly positively correlated with 25OH at all 3 trimesters (p<0.009). 3-epi–25OH at trimester 3 significantly positively correlated with trimester 3 25OH (p<0.001) and cord blood 25OH (p<0.015). Cord 3-epi–25OH also significantly positively correlated with 25OH at all 3 trimesters (p<0.031) and with cord 25OH (p<0.001). In the TIDM group, 3-epi–25OH at trimester 1 significantly positively correlated with 25OH at trimesters 1 and 2 (p<0.003). 3-epi–25OH at trimesters 2 and 3 significantly positively correlated with 25OH at all 3 trimesters (p<0.05) and cord 25OH (p<0.002). Cord 3-epi–25OH also significantly positively correlated with 25OH at all 3 trimesters (p<0.024) and with cord 25OH (p<0.001).Seasonal variation in maternal 3-epi–25OH levels was evident, Summer levels were significantly higher than all other seasons in the control group (p<0.001) and significantly higher than Spring (p<0.003) and Winter (p<0.001) in the TIDM group. The TIDM group had higher 3-epi–25OH levels in Autumn vs Winter (p=0.013). When compared within season, levels of 3-epi–25OH were significantly higher in the TIDM vs control group in both Spring (p=0.045) and Autumn (p=0.022). Increased maternal BMI significantly reduced cord 3-epi–25OH (BMI ≥25 kg/m2 vs ≥30 kg/m2, p=0.04). HbA1c was significantly negatively correlated with 3-epi–25OH at trimesters 1 and 2 (p=0.049; p=0.001) and with cord 3-epi–25OH (p=0.012).


#37, Day 1
Concentrations of 25-hydroxyvitamin D in umbilical cord blood and achievement of gross motor outcomes in infants

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Background: Persistence of the influence of vitamin D status at birth into infancy has recently been shown [1]. Apart from its well-documented role in bone mineralisation, vitamin D is implicated in muscle strength and severe vitamin D deficiency can delay gross motor development, such as walking in children [2]. Associations between low circulating 25-hydroxyvitamin D [25(OH)D], the biomarker of vitamin D status, and muscle weakness in older adults [3] have been replicated in adolescents [4]. Our aim was to explore associations between maternal and cord 25(OH)D concentrations and vitamin D supplementation during pregnancy and infancy and gross motor development in infants.

Methods: The Cork BASELINE Birth Cohort Study collected socio-demographic, dietary, anthropometric and supplement use data in maternal–infant dyads, from 15 weeks gestation. Blood from mothers at 15 weeks gestation and umbilical cords at delivery were processed to serum within 3hrs and stored at –80°C. Serum 25(OH)D concentrations in maternal–cord dyads (n 1050) were quantified using liquid chromatography–tandem mass spectrometry [LC–MS/MS], using a method which is traceable to the NIST higher order reference measurement procedure [5,6]. Fat mass (kg) and fat free mass (kg) were measured in 850 infants within 4 days of birth using air displacement plethysmography [PEA POD]. Data on attainment of gross motor outcomes: sitting independently, crawling, standing with support and standing independently, in accordance with WHO milestones [7], were collected. Factors associated with achievement of gross motor outcomes were explored using univariate analysis. Predictive models were developed using binary logistic regression.

Results: A subgroup of 379 term infants had complete data for this analysis, of whom 99% were Caucasian. Of the mothers in this subgroup 90% had a tertiary education, compared with 55% of the cohort overall. The main determinants of the ability to sit independently at 6 months, expressed as adjusted OR (95% CI), were a fat free mass at birth >80th centile (3.25kg) [1.95 (1.17, 3.24), P=0.011] and a maternal BMI at 15 weeks gestation >30kg/m² [0.50 [0.26, 0.98], P=0.041]. There were no associations between maternal serum 25(OH)D or maternal or infant vitamin D supplementation and any of the gross motor outcomes specified. On the basis of the correlation between maternal and cord 25(OH)D concentrations collected at time of delivery [1,8], maternal 25(OH)D at 30 and 50nmol/L would reasonably lead to a detection of cord 25(OH)D at ~25 and 40nmol/L, respectively. Infants with cord serum 25(OH)D >40nmol/L were less likely to sit independently at 6 months [0.64 (0.41, 1.01), P=0.051].

Conclusions: The current data suggests a link between cord 25(OH)D, lean body mass and achievement of the first gross motor outcome which warrants further investigation as it may have implications for skeletal and muscle development in childhood.

8. Kiely M. Personal communication.

#38 Day 1

Maternal 25-hydroxyvitamin D concentrations in early pregnancy are associated with body composition at birth

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Background: Obesity is a risk factor for low circulating 25-hydroxyvitamin D [25(OH)D], which is the biomarker of vitamin D status, and there are consistent negative associations between 25(OH)D and measures of adiposity in adults and children. Relatively lower maternal circulating 25(OH)D concentrations during late pregnancy have been associated with lower fat mass at birth and higher adiposity during early childhood [1]. To date, little is known about the effect of low vitamin D status at birth on body composition during the neonatal period. The aim of this study was to examine the associations between maternal and umbilical cord 25(OH)D concentrations and body composition at birth.

Methods: Serum 25(OH)D was quantified at 15 weeks gestation and in umbilical cord in 1050 maternal–infant dyads participating in the Cork BASELINE Birth Cohort Study, using liquid chromatography–tandem mass spectrometry [LC–MS/MS], using a method which is traceable to the NIST higher order reference measurement procedure [2,3]. Fat mass [FM] (kg) and fat free mass [FFM] (kg) were measured for 850 infants within 4 days of birth using air displacement plethysmography [PEA POD]. Fat mass index [FMI] and fat free mass index [FFMI] (kg/m2) were calculated. Binary variables were developed to describe antenatal and socio-demographic data and univariate analysis was used to explore the predictors of infants being in the highest quartile for FMI and FFMI at birth. On the basis of these analyses, predictive models were developed using binary logistic regression.

Results: In the subgroup of 850 maternal–cord dyads in the current analysis, the median (IQR) maternal serum 25(OH)D concentration at 15 weeks gestation was 56 (40–77 nmol/L) and 16 and 42% were <30 and <50nmol/L respectively [4]. The median (IQR) cord serum 25(OH)D was 31 (22–46 nmol/L) and 35 and 66% were <25 and <40 nmol/L, respectively. On the basis of the correlation between maternal and cord 25(OH)D concentrations collected at the time of delivery [5,6], maternal 25(OH)D at 30 and 50 nmol/L would reasonably lead to a detection of cord 25(OH)D at ~25 and 40 nmol/L, respectively. Cord serum 25(OH)D concentrations were not associated with being in the highest quartiles for either FMI or FFMI. Infants whose
mother's 25(OH)D was < 30nmol/L at 15 weeks gestation were less likely to be above the 80th percentile for FFM (kg) at birth (OR 0.475 [95% CI: 0.237, 0.954], P = 0.036) or in the highest quartile for FMI [OR 0.614 [95% CI: 0.372, 1.011], P = 0.055] compared to those with maternal concentrations ≥50nmol/L. Similarly, maternal 25(OH)D <50nmol/L reduced the odds ratio of an infant being in the highest quartile for FMI at birth [OR 0.686 [95% CI: 0.492, 0.950], P = 0.026].

Conclusions: This study has found that low 25(OH)D in early pregnancy reduced the odds of offspring being in the upper end of the distribution for both FMI and FFM at birth. We will continue to examine links between vitamin D status throughout early childhood and body composition.

5. Kiely M, Personal communication.

#39. Day 1
The C3-epimer of 25-hydroxyvitamin D3 [3-epi-250HD3] is quantifiable in almost all neonates and mirrors variation in serum 250HD3

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Background: There are no reference data for 25-hydroxyvitamin D [25(OH)D] concentrations in umbilical cord sera. Our aim was to quantify the determinants of cord serum 25(OH)D and propose reference intervals for 250HD3, 250HD2 and the 3-epi-250HD3 in the Cork BASELINE Birth Cohort Study, which is a large, well-characterised birth cohort at Northerly latitude (52°N).

Methods: Umbilical cord blood was processed to serum within 3hrs of collection at delivery and stored at ~80°C. Serum 25(OH)D was quantified in 1050 maternal-infant dyads using liquid chromatography–tandem mass spectrometry (LC–MS/MS), using a method which is traceable to the NIST higher order reference measurement procedure [1,2]. Due to the absence of reference thresholds for cord serum 25(OH)D, current IOM cut-offs for 25(OH)D in the population were used which specify deficiency < 30 nmol/L and suggest that 97.5% of the population requirements would be met at ≥ 50 nmol/L (3).

Results: Total serum 25(OH)D [sum of 25(OH)D3 plus 25(OH)D2] concentrations ranged from 4.7–111.3 nmol/L, the mean ± SD was 34.9 ± 18.1 nmol/L. The prevalence of 25(OH)D < 30 was 46% (62% in winter) and 80% were < 50 nmol/L (89% in winter). Among the 42% of women who took a vitamin D–containing supplement at 15 weeks gestation, 31% and 72% of the cords were < 30 and 50 nmol/L, respectively. 59 and 91% of infants born to women with serum 25(OH)D levels < 50 nmol/L at 15 weeks gestation were < 30 and 50 nmol/L, respectively. The main determinants of cord 25(OH)D [adjusted mean difference in nmol/L (95% CI)] were summer season of sampling [19.2 (17.4, 20.9), P < 0.0001], maternal 25(OH)D concentrations at 15 weeks [0.3 (0.26, 0.34), P < 0.0001] and the maternal use of a vitamin D containing supplement at 15 weeks [2.5 (0.6, 4.42), P = 0.01]. Smoking at 15 weeks gestation was a negative predictor of cord 25(OH)D [−4.8 (−7.8, −1.8), P = 0.002]. Serum 25(OH)D2 was detected in 98% of infants and the median concentration was 1.9 nmol/L, ranging from 0 to 38.9 nmol/L. The 3-epi-25(OH)D3 was detected in nearly all neonates (99.4%) with a range of 0 to 11.9 nmol/L; [median 2.9 nmol/L]. The median molar ratio of 25(OH)D3 to 3-epi-25(OH)D3 was 10.1 [interquartile range 8.8, 11.3], twice the molar ratio reported during pregnancy[4]. Concentrations of 3-epi-25(OH)D3 tracked 25(OH)D3 on a month-by-month basis (r = 0.880, P < 0.001).

Conclusions: We present the first large reference dataset of 25(OH)D in umbilical cord serum. The prevalence of very low 25(OH)D concentrations was high. These data show that the 3-epi-25(OH)D3 in infants at delivery tracks 25(OH)D3 and is present at twice the molar ratio than that evident in maternal serum. Should the C3-epimer be proven to have biological significance, this would have an impact on the quantification of 25(OH)D concentrations in cord sera.


#40. Day 1
Effect of vitamin D supplementation in infancy on bone mineral density of children aged 3 – 6 years: follow-up of a randomized controlled trial


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Background: Vitamin D status or parent-selected vitamin D supplementation in infancy have been associated with better bone growth and mineralization in later childhood. However, the data from randomized trials is scarce and conflicting. A recent meta-analysis showed inconsistent effects of vitamin D supplementation on bone mineral density of healthy children. In the Delhi Infant Vitamin D Supplementation Study (DIVIDS) we randomized 2079 neonates to weekly vitamin D or placebo until age 6 months. The supplementation increased length growth at 6 months. For the present DIVIDS–2 study we followed up the children, now aged 3–6 years, to measure bone structure and strength by quantitative ultrasound (QUS). The purpose of the study was 1) to determine the effect of vitamin D supplementation in infancy on bone structure and strength of children aged 3–6 years; 2) to evaluate the association of current vitamin D status with bone structure and strength.
Method: 796 DIVIDS children and their parents were contacted using their last known address and telephone number. They were invited to the study clinic for QUS of the distal radius and midshaft tibia, blood sampling for measurement of 25-hydoxyvitamin D3 (25OHD) by radioimmunoassay, as well as medical examination, anthropometry, and motor development testing. QUS data were expressed as Z scores and compared between treatment groups.

Results: Demographic characteristics did not differ at follow-up between children in the vitamin D and placebo groups. QUS Z scores for radius were mean -0.72 (95% CI -0.82 to -0.62, n=398) for the vitamin D group and mean -0.60 (95% CI -0.70 to -0.50, n=397) for the placebo group; P=0.11. For tibia, values for the vitamin D group were mean -0.57 (95% CI -0.67 to -0.47, n=398) and for the placebo group mean -0.53 (95% CI -0.63 to -0.43, n=398); P=0.62. Adjusting for factors associated with being followed up from the original trial gave almost identical results. Serum 25OHD concentrations were mean 25.7 nmol/L (95% CI 22.2 to 29.3, n=187) for the vitamin D group and mean 28.9 nmol/L (95% CI 25.4 to 32.4, n=185) for the placebo group; P=0.22. Concurrent factors associated with higher QUS Z scores for radius were older age at follow-up, visiting a doctor in the last month, greater dietary diversity as indicated by number of food groups eaten, and for both radius and tibia Z scores, being interviewed at follow-up during July to September (the Monsoon season).

Conclusions: In a large randomized controlled trial, vitamin D supplementation in infancy did not affect bone structure and strength in childhood.

#41, Day 1
Tooth development in children with vitamin D deficiency: the rachitic tooth in history

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Background: The formation of tooth dentine and enamel is a mineralization process that biochemically closely resembles ossification in bone. To what degree does vitamin D influence dental health in children? Objective: To ascertain whether vitamin D deficiency is linked to dental health.

Methods: Review of publications from the British Dental Association (BDA) and the Medical Research Council (MRC) who piloted research in this field between 1890 and 1950.

Results: Dental health deteriorated towards the end of the 19th century with increasing urbanization. School inspections in the 1890’s suggested that the majority of children suffered caries by the age of 10–12. Approximately 6% of volunteer military recruits to the Boer war were rejected on the grounds of poor dental health. The phrase “Can’s bite, can’t fight” was employed. Higher rates of dental caries were linked with poverty and rickets. The government founded the Committee on Physical Deterioration in 1903; ten years later the first research grant was given to study rickets by the MRC. Studies carried out in a number of types of dogs by May Mellanby showed that vitamin D deficiency damaged the development of teeth at the same time as bones and that this could be reversed with a diet high in vitamin D. She conducted a series of early randomized controlled trials in orphans too that showed lower rates of caries in children under 12 who were given diets higher in vitamin D. Recent research in children with specific syndromes and in gene knockout mice have confirmed a central role for vitamin D in tooth mineralization with effects on tooth structure, as described by May Mellanby. Vitamin D appears to have other significant effects on the ecological balance between a child’s gums and oral bacteria.

Conclusions: Early work with dietary manipulations in a dog model together with trials in institutionalized children suggested that vitamin D is an important protective factor against dental decay. These historical studies support the problem of the rachitic tooth. Although dental caries rates are much improved today, caries persist in a proportion of the UK population according to BDA surveys. What is less clear is the relevant significance of vitamin D deficiency to tooth development, at a population level, in the UK at present.

#42, Day 1
Seasonal variation in foetal lateral ventricular diameter: does maternal vitamin D deficiency impair foetal neurodevelopment?

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Background: There is growing evidence from observational epidemiological and animal studies that foetal vitamin D deficiency may be a risk factor for the development of neuropsychiatric disorders in adulthood, and that this may be associated with increased lateral ventricle diameter (ventriculomegaly) in the foetal brain. In the UK, maternal serum 25-hydroxyvitamin D concentrations exhibit seasonal variation, with peak levels after summer and the lowest levels in spring. If vitamin D status does indeed impact on neurodevelopment, seasonal variation in lateral ventricular diameter might be expected. We therefore conducted a retrospective observational study to determine whether there is seasonal variation in lateral ventricular diameter among foetuses undergoing routine ultrasound scans at 18–26 weeks of gestation.

Methods: Data from all pregnant women (n=35,594) having a routine foetal anomaly scan at 18–26 weeks gestation at the Royal London Hospital, UK, between February 2000 and February 2012 were examined. Isolated ventriculomegaly was defined as a lateral ventricle diameter ≥10 mm and ≤16 mm. Foetuses with a lateral ventricle diameter >16 mm, known neurological pathology or pathology affecting ventricular diameter were excluded. A total of 49,609 anomaly scans met inclusion criteria. Cosinor analysis was used to determine the presence or absence of seasonal variation in mean lateral ventricular diameter.

Results: We found evidence of a small but highly statistically significant (p<0.001) variation in mean lateral ventricular diameter, highest in October–December (6.59 mm), and lowest in April–June (6.53 mm). Mean lateral ventricular diameters in January–March (6.54 mm) and July–September (6.57 mm) were intermediate. Isolated ventriculomegaly was found in 118 foetuses (approximately 2 per 1000 pregnancies, consistent with reports from other settings). No seasonal variation in the proportion of foetuses with ventriculomegaly was found.

Conclusions: To our knowledge, this is the first demonstration of seasonal variation in foetal lateral ventricular diameter. Foetal ventricular size at the time of routine anomaly scans is likely to reflect in utero conditions one to two calendar year quarters previously. Therefore, the larger mean foetal lateral
ventricle size seen in October–December is likely to relate to adverse exposure in June–September, when maternal vitamin D status is highest. Our data do not therefore support a role for vitamin D in protection against foetal lateral ventriculomegaly. Alternative explanations for our findings should be considered: seasonal variation in maternal concentrations of folic acid, which plays a key role in neurodevelopment and which is degraded by cutaneous exposure to ultraviolet radiation, may be implicated.

#43, Day 1
The spine and vitamin D in children with sickle cell anae mia

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Background: Back pain is relatively common in young patients suffering painful crises from sickle cell anaemia. In a proportion of these patients micro-infarctions in the vertebral body lead to changes that can be seen on standard radiographs: the vertebral central bodies collapse, leading to an H–type or fish–mouth appearance. The frequency, pattern and time–course of these bony changes is unclear, as is their relationship to other measures of bone health. Sickle cell patients frequently have low levels of vitamin D. How significant is this vitamin in maintaining vertebral structure? Objective: To determine the relationship between vitamin D deficiency and vertebral changes in a cohort of London children with sickle cell anaemia.

Methods: A retrospective series of all radiographs from the paediatric sickle cell clinic at a single west London Hospital were reviewed visually for morphological changes in the vertebral column. Results were linked to biochemical, haematology- and vitamin D measures in the patients. 28 patients with HbSS received 40 radiographs or MRI studies of their chests or spines between 2010 and 2012. 4 patients with HbSC and HbSβthal had 10 radiographs in this time.

Results: No unusual vertebral shapes were found in any patient aged 12 years or younger in the clinic series. Two patients with HbSS developed ‘H-type’ or ‘fish-mouth’ vertebrae between 12 and 16 years of age. Both had multiple admissions with painful crises as adolescents, they had normal trans–cranial Doppler investigations. Both showed significant levels of intravascular haemolysis and vitamin D levels of ≤10 nmol/l were documented. 6 other patients had similarly deficient levels of vitamin D, but they did not have frequent admissions, or lower levels of haemolysis. They did not show visible changes in their vertebral bodies.

Conclusions: Vertebral bodies rarely show morphological changes in young children with sickle cell disease in this cohort. Those patients requiring frequent admissions for painful crises together with vitamin D deficiency, can develop vertebral changes. However patients with low vitamin D but few painful crises had normal vertebral morphology. Such observations from a relatively small clinic suggest vitamin D deficiency acts as a comorbid factor in leading to changes in the vertebral bodies. Larger studies with measures such as bone densitometry, estimates of parathyroid hormone or glycoproteins related to bone remodeling such as osteopontin may help clarify this pattern.

#44, Day 1
Longitudinal and seasonal changes in serum 25-hydroxyvitamin D (25-OHD) levels in different age groups, and clinical implications

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Background: Longitudinal changes in serum 25-OHD levels during aging have not been studied extensively. When describing the longitudinal change, it is highly important to adequately adjust for seasonal variation in serum 25-OHD levels. The research aims of the current study are: (1) To examine longitudinal changes in serum 25-OHD levels in different age groups; (2) To describe the seasonal variation in different age groups using a cosine function; (3) To examine whether optimal serum 25(OH)D levels for physical functioning differ according to season.

Methods: Two answer the first two research aims, data of the Longitudinal Aging Study Amsterdam (LASA) were used, an ongoing cohort study. Two different cohorts were included: (1) younger cohort: aged 55–65 years at baseline, n=738, follow-up of six years; (2) older cohort: aged 65–88 years at baseline, n=1320, follow-up of thirteen years. Linear Mixed Models was used to examine the longitudinal changes within the two cohorts; seasonal variation was modeled by adding a cosine function with a period of one year to the model. To answer the third research aim, baseline data of the B-Vitamins for the Prevention Of Osteoporotic Fractures (B-PROOF) study were used, an RCT on B-vitamins and fracture risk in community-dwelling persons aged 65+. Physical functioning was assessed using three different tests: the walking test, the chair stands test and the tandem stand. Restricted cubic spline functions and plots were used to estimate the optimal cut-off of serum 25-OHD in the relationship with physical functioning stratified by winter (n=1372) and summer season (n=1441).

Results: At baseline, average serum 25-OHD levels were 56.5 nmol/l in the younger cohort and 51.1 nmol/l in the older cohort. In the younger cohort, a longitudinal increase in mean serum 25-OHD levels of 5 nmol/l in six years was observed; in the older cohort, a longitudinal decrease in mean serum 25-OHD levels of 5 nmol/l in thirteen years was observed. The seasonal variation was +/- 11 nmol/l in the younger cohort, and +/- 7 nmol/l in the older cohort. The optimal serum 25-OHD level in the relation with physical functioning was between 60 and 70 nmol/l for both seasons.

Conclusions: Serum 25-hydroxyvitamin D levels changed during follow-up with increasing levels in persons aged 55–65 years, and decreasing levels in persons aged 65–88 years. On average, the seasonal variation was larger than the longitudinal change. Our findings implicate that vitamin D supplementation becomes more important in older age groups and during wintertime. Another implication might be that serum 25-OHD measurements during summertime should be repeated during wintertime, or that a higher threshold for vitamin D deficiency (i.e. 60–70 nmol/l) should be used in summer.
The effect of Vitamin D deficiency on the developing fetus: a pilot study

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Background: Vitamin D deficiency during pregnancy is a common yet under-recognised problem affecting >50% of Caucasian and >80% of Black/African-American and South Asian populations. Prenatal vitamin D deficiency in a rat pup model has been associated with ventriculomegaly and brain overgrowth and abnormal behaviour while a few studies have demonstrated an association between prenatal vitamin D deficiency and lower birthweight. To date, there is no study investigating the effect of maternal vitamin D deficiency on the human fetus. The aim of the study was to measure maternal Vitamin D levels in stored booking samples of healthy volunteers and correlate with total ventricular and supratentorial brain volumes and birthweight.

Methods: The study was approved by the West London Research Ethics Committee (07/H0707/105). Fetal brain MRI was performed in 40 healthy volunteers (mean 27.4 weeks; 21.3–37 weeks). Volumetric analysis of the lateral ventricles and supratentorial brain tissue was performed on 3D-reconstructed datasets. Birthweight was recorded and centiles were calculated using customised birthweight charts incorporating gestational age at birth, sex and maternal ethnicity. Vitamin D levels were measured retrospectively in stored booking serum samples using liquid chromatography–mass spectrometry.

Results: Vitamin D levels were below normal levels (<70 nmol/L) in 70% of women and were significantly lower in women of South Asian origin (p=0.004). Vitamin D levels significantly and positively correlated with birthweight centiles (r=0.331, p=0.042) and left ventricular volume (r=0.403, p=0.003) in the entire cohort and with supratentorial brain volume (r=0.543, p=0.024) in the deficient population only.

Conclusions: While this is a small pilot study, our results suggest a positive association between maternal Vitamin D levels and birthweight, left ventricular size and supratentorial brain volume.

Placental amino acid transport may be regulated by maternal vitamin D and vitamin D–binding protein: results from the Southampton Women’s Survey

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Background: Facilitated transporters, accumulative transporters and amino acid exchangers mediate transfer of amino acids across the placental syncytiotrophoblast into the fetal circulation, and the mRNA levels of several amino acid transporters relate positively to measures of fetal growth. These transporters contain putative vitamin D receptor response elements within their promoters, suggesting that amino acid transporters may be modulated by maternal vitamin D status, a measure previously shown to relate to adiposity and bone health of the offspring. We therefore aimed to establish whether maternal vitamin D and vitamin D-binding protein (DBP) levels might relate to the expression of amino acid transporters in human placenta.

Methods: We used data and samples from the Southampton Women’s Survey, a cohort of study of 3,159 pregnancies with information collected from the mothers before conception. With informed consent and ethical approval maternal serum
25-hydroxyvitamin D [25(OH)D] and DBP levels were measured at 34 weeks gestation by radioimmunoassay and placental samples were collected within 30 mins of delivery. A subset of tissue samples (n=91) were used for this analysis; selected based on availability of neonatal DXA data and maternal serum measures. Quantitative real-time PCR was used to measure amino acid transporter mRNA expression; all normalized to appropriate housekeeping genes. Pearson’s correlation (r) was used to explore the relationship between maternal 25(OH)D (n=91) and DBP (n=85) concentrations and placental amino acid transporter mRNA.

Results: Maternal 25(OH)D levels correlated positively with mRNA expression of the amino acid exchangers ASC1 (r = 0.23, p = 0.029) and y+LAT1 (r = 0.32, p = 0.002) and the facilitated transporter LAT3 (r = 0.31, p = 0.003). DBP levels correlated positively with mRNA expression of the facilitated transporters LAT3 (r = 0.22, p = 0.04), LAT4 (r = 0.28, p = 0.01) and LAT1 (r = 0.20, p = 0.06) as well as the exchanger y+LAT2 (r = 0.23, p = 0.033).

Conclusion: These results suggest that maternal 25(OH)D and DBP might regulate the expression of placental amino acid transporters and potentially influence the transfer of amino acids to the fetus. The correlations between DBP levels and several amino acid transporters suggest that vitamin D delivery may be important for placental function, but further work is now required to establish whether these associations are causal.

#48, Day 1
Effect of food and vitamin D supplements on the serum 25-hydroxyvitamin D concentration in children between October and April in a northern country

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Background: The main source of vitamin D for people is exposure to sunlight (1,2). However, in northern countries such as the Netherlands, the skin only synthesizes vitamin D between April and October (L3). Because of the importance of vitamin D for many functions in the human body and the limited vitamin D synthesis in the skin between October and April, it is important to have another source of vitamin D during these months. Since vitamin D is also obtained from dietary sources and vitamin D supplements, this study investigated the influence of food and vitamin D supplements on the serum 25-hydroxyvitamin D [25(OH)D] concentration in children in the Netherlands between October and April.

Methods: Children aged 1-18 years who visited the general pediatrician with a complaint whereby serum 25(OH)D concentration was determined, were selected. The intake of vitamin D was calculated based with a dietary questionnaire.

Results: 511% of the 174 children had a serum 25(OH)D concentration below 50 nmol/L, 9.2% had a serum 25(OH)D concentration below 30 nmol/L. Adolescents showed lower concentrations compared to younger children. There was a positive correlation between the total amount of vitamin D obtained from food and the serum 25(OH)D concentration (r = 0.218, P = 0.004). The intake of milk contributed more to the serum 25(OH)D concentration compared to the intake of artificial supplementation, butter or fish. There was a positive trend between the intake of whole milk and the serum 25(OH)D concentration (r = 0.116, P = 0.127).

Conclusion: In the absence of vitamin D synthesis by sunlight, vitamin D obtained from food has a significant influence on the serum 25(OH)D concentration in children. Therefore, we should pay more attention to food as a natural source of vitamin D.


#49, Day 1
Vitamin D status of rural Gambian mother–infant pairs at three months lactation

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Background: Vitamin D (VD) activity is assumed to be low in breast milk (1) and case reports of VD deficiency in exclusively breastfed infants may deter mothers from breastfeeding. However, current data are only from women with marginal VD status or in high–dose supplement trials. Relationships between maternal and infant VD status during breastfeeding are inconsistent. This observational study was conducted in a rural subsistence farming population in The Gambia (13°N), where UVB–containing sunlight is present all year. Mothers and their infants are constantly together, and women have face, neck, shoulders, arms and feet exposed during fieldwork and gardening.

Methods: Participants were 30 healthy rural Gambian mother–infant pairs (mean±SD maternal BMI 21.7±2.6 kg/m², infant length 61.8±4.9 cm, and weight 5.9±1.0 kg). Mean±SD maternal age was 25.6±6.4 years (range 16.7–36.2). All mothers were unsupplemented and reported breastfeeding exclusively. Median parity was 2 (range 1–9). All infants were singleton–born, 47% were male, mean±SD age was 13.6±1.8 (range 10.8–16.4) weeks. Blood samples were collected by venepuncture from 100% of pairs, 15ml from mothers (overnight fasted) and 3ml from infants. Samples were stored at ~70°C and transported frozen to Cambridge, UK. Mother and infant VD status was assessed by serum concentration of 25–hydroxyvitamin D (25(OH)D) by chemiluminescent immunoassay (DiAsorin Ltd, intra-assay CV 3.5% estimated from duplicates, DEQAS accredited).

Results: Mean infant 250HD was 75.8±16.1 nmol/L (range 46.4–116.0). Mean maternal 250HD was 58.8±15.9 nmol/L (37.3–100.5). All subjects were above 25nmol/L, 17 mothers and 18 infants between 50–80nmol/L, and 3 mothers and 11 infants above 80nmol/L. There was no significant correlation between mother and infant 250HD concentration (r=0.2, p=0.2).

Conclusions: This is the first report of VD status in Gambian breastfed infants, whose mothers have unrestricted exposure to tropical sunlight. Maternal VD status was similar to our previous data at 13 weeks lactation [2]. These data suggest that rural Gambian breastfed infants have sufficient VD status for bone health, despite implications that BM contains little VD. There was no significant correlation in VD status between Caucasian, supplemented mother–infant pairs at 4 months in Denmark [3], or unsupplemented pairs at 18 months.
15 weeks in Finland [4]. VD metabolite transfer in utero, direct infant UVB-sunlight exposure and direct infant supplementation may be important contributors to infant VD status. Further data from this study on potential determinants of VD status are being analysed, including UVB exposure using dosimeter badges (Sciencent Ltd), VD-binding protein concentration in plasma and BM (ELISA, Pathway Diagnostics), VD and 25OHVD in BM [5], calcium and phosphorus in BM [6], and BM intake by dose-to-the-mother method [7]. Comparative studies on mother-infant pairs in contrasting geographical locations are lacking [8]. A parallel study is planned in Britain, where UVB-sunlight is seasonal and exclusive breastfeeding not widely practiced.


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#50, Day 1
Feasibility and acceptability of assessing vitamin D status in primary schoolchildren using a finger-prick dried capillary blood spot method

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Background: Vitamin D status of inner city children may influence their respiratory health, but performing venesection in large numbers of children is challenging, especially among young children.

Methods: As part of a study examining the impact of the introduction of the London Low Emission Zone on children’s respiratory health, we assessed the feasibility and acceptability of a finger prick dried blood spot method for assessing vitamin D status (Pro-Diagnostics, London).

Results: Of 320 Year 4 children (aged 8-9 years) at 9 schools visited in Nov-Dec 2013, 195 (61%) participated in the health assessment and 88 of those (45%) had the finger prick test. The parents of 32 children did not give permission for the finger prick test; 90 children were not tested for a variety of reasons, including 15 from one school which asked us not to offer the finger prick test. Mean age was closely similar between those who had the finger prick test and those who did not (8.8 ± 0.3 yr and 8.7 ± 0.3 yr, respectively [± SD]). There was one instance of a child feeling faint after the test; otherwise there were no adverse events. Children were much more enthusiastic about having the finger prick test than we expected, and parents were for the most part willing to give their consent (84% of all participants). At the time of writing, samples had been analysed for 68 children (33 boys, 35 girls). The mean 25(OH) vitamin D was 65.7 ± 35.1 nmol/L, with a range of 15.8-140.0 nmol/L, which is within the range of published values. 29 children had a 25(OH) vitamin D level defined as deficient or insufficient (i.e. <50 nmol/L).

Conclusions: A finger-prick dried blood spot method is feasible and acceptable way of assessing the vitamin D status of primary schoolchildren. In our experience, when conducted as part of a suite of tests, a dedicated member of staff was required to do the finger prick test as it was quite time-consuming.