7th International Symposium on Nutritional Aspects of Osteoporosis
Lausanne/Switzerland, 7–9 May 2009

www.congrex.ch/isnao2009
Welcome

18 years after the first Symposium on Nutritional Aspects of Osteoporosis in 1991, the topic remains a puzzling and difficult field of investigation, because the step from animal research to human trials confronts the variability of human preferences and food habits. In addition, capturing the effects on bone needs long-term investigations.

The 7th symposium will offer again an update and overview of the scientific efforts and achievements over the last years. It will gather the main investigators in the field and offer them an opportunity to meet and exchange. In fact, this symposium is still the only international meeting exclusively devoted to the interactions between nutrients and bone health.

We welcome you in Lausanne and wish you a fruitful meeting.

Peter Burckhardt  Bess Dawson-Hughes  Connie Weaver
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Scientific Program Overview

Wednesday, 6 May 2009  
Room Delta

08.00 – 09.00  
Registration

09.00 – 09.15  Opening

09.15 – 11.15  
Protein

11.15 – 11.45  Coffee break & Posters

11.45 – 12.45  
Calcium (Part I)

12.45 – 14.00  
Lunch  
(free admission for symposium delegates)

14.00 – 16.15  
Calcium (Part II)

16.15 – 16.45  Coffee break & Posters

17.00 – 18.30  
Registration

Thursday, 7 May 2009  
Room Richemont

09.00 – 09.15  Opening

09.15 – 11.15  
Protein

11.15 – 11.45  Coffee break & Posters

11.45 – 12.45  
Calcium (Part I)

12.45 – 14.00  
Lunch  
(free admission for symposium delegates)

14.00 – 16.15  
Calcium (Part II)

16.15 – 16.45  Coffee break & Posters

16.45 – 18.00  
Calcium (Part III)
Scientific Program Overview

Friday, 8 May 2009
Room Richemont

08:30–10:15
Trace Elements, Phosphorus, Diabetes

p. 8

10:15–10:45 Coffee break & Posters

10:45–12:30
Vitamin D (Part I)

p. 9

12:30–14:00
Lunch (free admission for symposium delegates)

14:00–16:00
Vitamin D (Part II)

p. 10

16:00–16:30 Coffee break & Posters

16:30–17:45
General Nutrition

p. 11

17:45–18.15 Introduction to Acid Base

p. 11

18:45
Bus departure Hotel Lausanne Palace

19:00
Bus departure Hotel Château d’Ouchy

20:00
Aperitif followed by Candlelight dinner at the Castle of Chillon

Saturday, 9 May 2009
Room Richemont

08:30–10:00
Acid Base (Part I)

p. 12

10:00–10:15 Coffee break & Posters

10:15–12:00
Acid Base (Part II)

p. 13

End of the Symposium

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Acknowledgements
The organizers express their thanks and appreciation to all those who are generously contributing to the success of this meeting.

Main Sponsors
- Nestlé
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Sponsors
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- Procter & Gamble
- Servier
- Wyeth

Contributors
- Glaxo Smith Kline
- Eli Lilly
- International Osteoporosis Foundation
- MSD
- National Dairy Council US
- Opfermann
- Schweizerische Milchproduzenten

Endorsement
This symposium is endorsed by the International Osteoporosis Foundation
Scientific Program

Thursday, 7 May 2009

09:00 – 18:00 Poster on display

09:00 – 09:15 Opening
P. Burckhardt (Lausanne, CH)

09:15 – 11:15 Protein
Chairs: B. Dawson-Hughes (Boston, USA)
R. Rizzoli (Geneva, CH)

09:15 Dietary protein and bone mass accrual
R. Rizzoli, J. Bonjour, S. Ferrari, T. Chevalley (Geneva, CH)

09:45 Protein effects on bone and muscle
R. Prince (Nedlands, AUS)

10:15 Positive impact of dietary protein on bone: results of a systematic review and meta-analysis
A.L. Darling, D.J. Torgerson, C.E. Hewitt, D.J. Millward, S. Lanham-New (Guildford, York, UK)

10:30 Protein intake during weight loss: effects on bone
S. Shapses (New Brunswick, USA)

11:00 Folate, vitamin B12, homocysteine methylenetetrahydrofolate reductase C667T polymorphism to bone mineral density in Saudi postmenopausal women
M. Qari, M.-S. Ardawi, A. Rouzi, A. Maimany (Jeddah, SA)

11:15 – 11:45 Coffee break and poster exhibition

*Abstracts
11:45–16:15 **Calcium (Part I + Part II)**

**Room Richemont**

**Chairs:** C. Weaver (West Lafayette, USA)
R. Prince (Nedlands, AUS)

### Part I

**11:45**

**Calcium metabolism and requirements in Adolescents:**
Eastern setting
*W. Lee (Guildford, UK)*

**12:15**

**Calcium metabolism and requirements in Adolescents:**
Western setting
*C. Weaver (West Lafayette, USA)*

**12:45**

**Lunch**

### Part II

**14:00**

**Calcium and Exercise—in adults**
*R. Daly (Melbourne, USA)*

**14:30**

**Calcium and Exercise—in children**
*J. Lappe (Omaha, USA)*

**15:00**

**Calcium supplementation plays a positive role in bone and body composition in Chinese adolescents**
*G. Ma, Q. Zhang, J. Yin, A. Liu, W. Du, X. Wang, X. Hu (Beijing, CHN)*

**15:15**

**Calcium supplementation in pregnancy and lactation, and its possible consequences for the short-term and later health of mother and child**
*A. Prentice (Cambridge, UK)*

**16:15–16:45** **Coffee break and poster exhibition**

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*Abstracts*
16:45 – 18:00  **Calcium (Part III)**  
Room Richemont  
Chairs: B. Dawson-Hughes (Boston, USA)  
P. Burckhardt (Lausanne, CH)  

16:45  
**Effect of high calcium and vitamin D diets on changes in body fat, lean mass, and bone mineral density by self-controlled dieting for 4 months in young Asian women**  
T. Hirota, I. Kawasaki, T. Aoe, K. Hirota (Kyoto, Osaka, JP)  

17:00  
**Longitudinal effects of a calcium and Vitamin D RCT in an elderly women cohort**  
R. Prince (Nedlands, AUS)  

17:30  
**Setting Calcium requirements**  
C. Weaver (West Lafayette, USA)  

18:00  
End of the session  

*Abstracts*
08:30 – 18:15  **Poster on display**  
**Poster Area**

08:30 – 10:15  **Trace Elements, Phosphorus, Diabetes**  
Room Richemont  
**Chairs:** P. Burckhardt (Lausanne, CH)  
J. Lappe (Omaha, USA)

08:30  Trace elements and bone  
*F. Jakob (Wurzburg, D)*

09:00  Phosphorus and Bone  
*C. Lamberg-Allardt (Helsinki, FIN)*

09:30  Seasonal differences in mineral homeostasis and bone metabolism in response to oral phosphate loading in older northern Chinese adults  
*B. Zhou, L. Yan, X. Wang, I. Schoenmakers, G. Goldberg, A. Prentice (Shenyang, CHN; Cambridge, UK)*

09:45  Diabetes and Bone  
*L. Hofbauer (Dresden, D)*

10:15 – 10:45  **Coffee break and poster exhibition**

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*Abstracts*
### Scientific Program

**Friday, 8 May 2009**

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<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>10:45–12:30</td>
<td><strong>Vitamin D (Part I)</strong></td>
<td>Richemont</td>
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<td></td>
<td><strong>Chairs:</strong> B. Dawson-Hughes (Boston, USA)</td>
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<td>M. Garabedian (Paris, F)</td>
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<tr>
<td>10:45</td>
<td><strong>Vitamin D and muscle</strong></td>
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<td><em>H. Bischoff-Ferrari (Zurich, CH)</em></td>
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<td>11:15</td>
<td><strong>Vitamin D and bone health in adults</strong></td>
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<td><em>P. Lips (Amsterdam, NL)</em></td>
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<tr>
<td>11:45</td>
<td><strong>Vitamin D effects beyond the musculoskeletal system</strong></td>
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<td><em>R. Bouillon (Leuven, B)</em></td>
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<tr>
<td>12:15</td>
<td><strong>Maternal vitamin D status determines volumetric bone mineral density of the newborn</strong></td>
<td>22*</td>
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<tr>
<td>12:30–14:00</td>
<td><strong>Lunch</strong></td>
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*Abstracts*
14:00 – 16:00 **Vitamin D (Part II)**

**Room Richemont**

Chairs: H. Bischoff-Ferrari (Zurich, CH)
P. Lips (Amsterdam, NL)

14:00  
Vitamin D in children and adolescents
*M. Garabedian (Paris, F)*

14:30  
Effects of vitamin D on bone health in healthy young adults
*K. Cashman (Cork, IRL)*

15:00  
Vitamin D effects on bone structure in childhood and aging
*K. Zhu (Nedlands, AUS)*

15:30  
Metabolomic studies identify true responders from non-responders to vitamin D supplementation in postmenopausal women
*C. Moniz, T.J. Ong (London, Aberdeen, UK)*

15:45  
Effects of a vitamin D and calcium supplementation on blood pressure and heart rate in community-dwelling older individuals – a randomized prospective double-blind study
*M. Pfeifer, H. Minne, A. Fahrleitner-Pammer, H. Dobnig (Bad Pyrmont, D; Graz, A)*

16:00 – 16:30 **Coffee break and poster exhibition**

*Abstracts*
16:30 – 17:45 General Nutrition
Room Richemont
Chairs: C. Weaver (West Lafayette, USA)
K. Cashman (Cork, IRL)

16:30
Dietary patterns and bone health
H. Macdonald (Aberdeen, UK)

17:00
Nutritional factors that influence change in bone density and stress fracture risk among young female cross-country runners

17:15
A dietary pattern that predicts physical performance in an elderly population
J. Nieves, E. Vasquez, Y. Gu, J. Luchsinger, Y. Stern, N. Scarmneas (New York, West Havenstraw, USA)

17:30
Impact of hesperidin, a citrus flavanone, in improving bone metabolism in age-related models of bone loss
M.-N. Horcajada, V. Habauzit, L. Ameye, I.-L. Nielsen, A. Trzeciakiewicz, W. Chee, V. Coxam, M.-J. Davicco, G. Williamson, E. Offord Cavin (Saint Genes Champanelle, F; Lausanne, CH)

17:45 – 18:15 Introduction to Acid-Base
Room Richemont

17:45
Acid-base and bone: a basic science update
D. Bushinsky (Rochester, USA)

18:15
End of the session

18:45
Bus Departure main entrance Hotel Lausanne Palace
19:00
Bus Departure main entrance Hotel Château d’Ouchy
20:00
Aperitif followed by Candlelight dinner at the Castle of Chillon

*Abstracts
08:30 – 12:00 **Poster on display**  
*Poster Area*

08:30 – 10:00 **Acid base (Part I)**  
*Room Richemont*

**Chairs:** H. Macdonald (Aberdeen, UK)  
S. Lanham-New (Guildford, UK)

08:30 **Dietary alkalinity and bone health – current controversies: future perspective**  
*S. Lanham-New (Guildford, UK)*

09:00 **Bicarbonate affects bone turnover and muscle performance**  
*B. Dawson-Hughes (Boston, USA)*

09:30 **Effects of mineral waters on bone metabolism:**  
*Alkalinity over Calcium*

P. Burckhardt (Lausanne, CH)

10:00 – 10:15 **Coffee break and poster exhibition**

*Abstracts*
10:15–12:00 **Acid base (Part II)**  
Room Richemont

Chairs: B. Dawson-Hughes (Boston, USA)  
P. Burckhardt (Lausanne, CH)

10:15 **Bone-anabolic impact of dietary high protein intake compared with effects of low potential renal acid load, endogenous steroid hormones, and muscularity**  
*T. Remer (Dortmund, D)*

10:45 **Percentage lean body mass is lower with a higher dietary acid-base load in women aged 18 to 79 years**  

11:00 **The acid-ash hypothesis of osteoporosis: a meta-analysis of the effect of dietary acid-ash load on calcium balance**  

11:15 **Which fruit and vegetables protect bones?**  
*A.C. Hardcastle, L. Aucott, W. Fraser, D.M. Reid, H. Macdonald (Aberdeen, Liverpool, UK)*

11:30 **NaCl leads to metabolic acidosis**  
*L. Frassetto (San Francisco, USA)*

12:00 **End of the symposium**

*Abstracts*
The posters may be viewed during the coffee and lunch breaks.

Calcium absorption from fortified ice-cream formulation compared with calcium absorption from milk

Alkalinity of mineral water alone does not inhibit bone resorption
E. Wynn, M.-A. Krieg, P. Burckhardt (Lausanne, CH)

Is there a correlation between oral calcium intake and bone density?
C. Günther, D. Heinzl, O. Günther, J. Niemeyer, D. Arnold-Dahmen (Bad Fussing, D)

High sodium chloride intake might contribute to muscle wasting via low-grade metabolic acidosis
J. Buehlmeier, P. Frings-Meuthen, N. Baecker, P. Stehle, M. Heer (Cologne, Bonn, D)

Vitamin D status and the association with forearm bone mass in Chinese Tibetan and Han nationality children and adolescents
Q. Zhang, X. Hu, H. Guo, L. Zhang, B. Zhang, J. Zhang, G. Zeng, G. Ma (Beijing, Sichuan, CHN)

Vitamin D inadequacy in a the Jordanian female population – FiJoNOR survey
B. Masri (Amman, JOR)

The importance of timing potassium bicarbonate supplementation to affect acid-base balance
G. Boehme, P. Frings-Meuthen, J. Buehlmeier, M. Heer (Cologne, D)

Analysis of bioavailable phosphorus content in differently processed cereals
S.T. Itkonen, P. Ekholm, V.E. Kemi, C. Lamberg-Allardt (Helsinki, FIN)
Positive correlations between vitamin D status and bone health in southern UK premenopausal women: preliminary results from the D-FINES study

Differences in soluble phosphorus content of foods
H.J. Karp, P. Ekholm, V.E. Kemi, C. Lamberg-Allardt (Helsinki, FIN)

Sex steroid hormones in diabetic type 2 osteoporotic men
M.R. Mascarenhas, M.R. Carvalho, A. Gonçalves, V. Simões, J. Camolas, J. Vieira, D. Santos Pinto, M. Bicho, I. do Carmo (Lisbon, P)

Low calcium diet – the risk of carriage disorders and osteopenic syndrome in adolescents
S. Kotova, N. Karlova, K. Savelyeva (St. Petersburg, RUS)

Quercetin and grape seed extract affect MC3T3-E1 preosteoblast proliferation and inhibit osteoclastogenesis
J.R. Hiess, W.H. Chua, M.C. Kruger (Palmerston North, NZ)

The effect of calcium intake on bone growth, bone turnover, bone density and bone strength in young growing rats
S. Viguet-Carrin, P. Ammann, J. Vuichoud, F. Scalfo, L. Ameye, E. Offord Cavin (Lausanne, Geneva, CH)

Counterintuitive relationship between IGF-1 and bone turnover in Irish professional jockeys

Effect of protein intake on volumetric bone parameters in healthy Spanish women
Relationship between bone mineral density, lean body mass, vitamin D status and parathyroid hormone in postmenopausal women: a prospective study
*M.-S. Ardawi, M. Qari, A. Rouzi, R. Radady, A. Maimany (Jeddah, SA)*

Vitamin D status in relation to bone mineral density, bone turnover markers and vitamin D receptor genotypes in Saudi pre- and postmenopausal women
*M.-S. Ardawi, M. Qari, A. Rouzi, R. Radady, B. Mustafa (Jeddah, SA)*

Assessment of vitamin D status in Saudi men with osteoporosis
*M.-S. Ardawi, T. Bahksh, M. Qari, A. Rouzi, A. Rouzi, R. Radady, A. Maimany (Jeddah, SA)*

Effectiveness of potassium bicarbonate administration to prevent sodium chloride-induced bone loss
*P. Frings-Meuthen, J. Buehlmeier, N. Baecker, M. Heer (Cologne, D)*

Hospitalization in a department of internal medicine, a window of opportunity for vitamin D replenishment
*M. Nodelman, G. Rozen, Z. Shen-Orr, S. Ish-Shalom (Haifa, IL)*

Choice of treatment for vitamin D deficiency in residents of an institution for developmentally-disabled, sunshine or supplement?
*Y. Alsberg Poran, G. Rozen, Z. Shen-Orr, S. Ish-Shalom (Jerusalem, Haifa, IL)*

The effect of 1000 IU of vitamin D2 on increasing 25OHD concentration decreases as baseline 25OHD concentration increases
*K. Zhu, D. Bruce, A. Devine, R. Prince (Perth, AUS)*

North versus south differences in sunlight exposure and seasonal vitamin D status of UK postmenopausal women: results from a longitudinal study
Low calcium-to-phosphorus ratio in habitual diets interfere with calcium and bone metabolism in healthy pre-menopausal women with in a generally adequate calcium intake
V. Kemi, M. Kärkkäinen, H. Rita, M. Laaksonen, T. Outila, C. Lamberg-Allardt (Helsinki, FIN)

Is salt sensitivity the link between hypertension and osteoporosis?
L. Frassetto, O. Schmidlin, A. Sebastian (San Francisco, USA)

Effect of a low carbohydrate weight-reducing diet versus a high fruit and vegetable weight loss diet and a weight control group on markers of bone turnover
R.H.T. Gannon, R. Hiscutt, H. Truby, H. Macdonald, D.P. Lovell, S. Shaptes, W.D. Fraser, J. Dutton, S. Lanham-New (Lausanne, CH; Guildford, UK; Herston, AUS; Aberdeen, UK; New Brunswick, USA; Liverpool, UK)

Effects of milk basic protein on RANKL+ T cell-mediated bone metabolism in food-sensitive enteropathy
A. Ono, H. Nakajima-Adachi, Y. Morita, A. Serizawa, H. Kiyono, S. Hachimura (Kawagoe, Tokyo, JP)

Vitamin D concentration is associated with muscle mass in men
R. Kallikorm, M. Kull, M. Lember (Tartu, EST)

Preliminary analysis of the effects of a fruit and vegetable intervention trial on net endogenous acid production and skeletal health: results from the US Women's Healthy Eating and Living (WHEL) study
M. Abbate, Y. Jeanes, S. Lanham-New, L. Frassetto (London, Guildford, UK; San Francisco, USA)

Altered antioxidant status in adolescent female gymnasts compared to age-matched sedentary controls: impact on indices of bone health
E. Alshammari, J. Nurmi-Lawton, S. Shafi, A. Taylor, G. Ferns, S. Lanham-New (Guildford, UK)
Extensive vitamin D deficiency among Kuwaiti adolescent females during the summer period: effects of lifestyle habits and implications for PBM attainment
K. Alyahya, Z. Al-Mazidi, J. Morgan, W. Lee, J. Berry, S. Lanham-New (Kuwait, KWT; Guildford, Manchester, UK)

Extensive vitamin D deficiency/insufficiency in Saudi Arabian adolescent males and females: implications for peak bone mass attainment
M. Al-Ghamdi, S. Lanham-New, J. Khan (Jeddah, SA; Guildford, UK)

A meta-analysis to quantify the contribution of dietary phosphate to the progression of osteoporosis under the acid-ash diet hypothesis

Greater intake of protein from meat enhances calcium retention from a low calcium diet in healthy postmenopausal women: A controlled feeding study
F. Roughead, L.K. Johnson, J.R. Hunt (Minnetonka Grand Forks, USA)
**Instructions for Authors**

**Oral Presentations**

The session room will be equipped with a PC and a data projector for PowerPoint presentations. PowerPoint presentations must be handed in at the Speakers Service Center (SSC) by means of a data carrier (CD-Rom or USB-stick) or via your own laptop. It is essential for the smooth running of the symposium that all speakers hand in their presentations at least one hour before the beginning of their sessions (not lectures). Speakers will have the opportunity to review their presentations on a PC available at the SSC. The SSC is located in Room Richemont.

**Posters**

All posters are on display in the poster area for the duration of the symposium.

Participants are invited to visit the poster exhibition during the coffee and lunch breaks. Authors are kindly asked to be present during the coffee and lunch breaks.

<table>
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<tr>
<th>Mounting Time</th>
<th>Presentation Time</th>
<th>Removal Time</th>
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<tbody>
<tr>
<td>Thursday, 7 May 2009</td>
<td>From Thursday, 7 May 2009 Until Saturday, 9 May 2009</td>
<td>Saturday, 9 May 2009 12:00 – 13:00</td>
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Please note that the mounting and removing of the posters is the responsibility of the authors. Posters that have not been removed by the author at 13:00 on Saturday, 9 May 2009 are removed and disposed by the congress staff.

**Poster measurements**

Height: 180 cm / 70”
Width: 120 cm / 48”

**Publication**

Invited speakers and authors of oral presentations are asked to provide a manuscript which will be published by Springer in a book. All accepted abstracts are published on the symposium website [www.congrex.ch/isnao2009](http://www.congrex.ch/isnao2009), and also in this program.
General Information

Location
Hotel Lausanne Palace,
Grand-Chêne 7–9
1002 Lausanne / Switzerland

The Hotel Lausanne Palace is located in the city centre. For further information please visit www.lausanne-palace.com

Date
Thursday, 7 May – Saturday, 9 May 2009

Official Language
English (no simultaneous translation)

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Website
www.congrex.ch/isnao2009
The registration fee for conference participants includes:
• The access to the scientific sessions
• The final program including the abstracts
• The lunch on Thursday and Friday
• Two coffee breaks on Thursday and Friday, one coffee break on Saturday

Pre-Registration Pre-registered participants can pick up their symposium documents at the congress secretariat during the official opening times.

Onsite-Registration For onsite-registration, payments need to be done either by credit card or cash. Onsite registrants cannot be guaranteed to receive all symposium documents.
Registration

Cancellation

In case of cancellation, the fees minus handling charges (25%) will be refunded, provided the cancellation is made in writing up to 2 April 2009. After this date no refund can be made for cancellations. For any name changes a fee of € 30 will be charged.

Disclaimer

The participant acknowledges that he / she has no right to lodge damage claims against the organisers should the holding of the congress be hindered or prevented by unexpected political or economic events or generally by force majeure, or should the non-appearance of speakers or other reasons necessitate program changes. With registration, the participant accepts this proviso.

Registration Desk and Congress Secretariat

All the symposium documents will be handed out to registered participants during the following opening hours:

- Wednesday, 6 May 2009 17:00 – 18:30
- Thursday, 7 May 2009 08:00 – 18:30
- Friday, 8 May 2009 08:00 – 18:30
- Saturday, 9 May 2009 08:00 – 12:30

Contact Information

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www.congrex.ch/isnao2009
### Social Events

**Friday, 8 May 2009**

#### Dinner at Castle Chillon

A candlelight dinner will take place at the medieval castle of Chillon on Friday, 8 May 2009.

A bus transfer is organised from both the Hotel Lausanne Palace and the Hotel Château d’Ouchy to the Castle of Chillon.

**Bus departure:** 18:45, main entrance Hotel Lausanne Palace  
19:00, main entrance Hotel Château d’Ouchy

**Admission fee**  
Active participants € 70  
Accompanying persons € 100

Places are limited. We advise you to register early for the candlelight dinner. For onsite registrations, places are subject to availability.

#### Lunches & Coffee Breaks

On Thursday, 7 May and on Friday, 8 May 2009 lunches are provided. There is no lunch provided on Saturday.

The lunches take place in the Salon J.P. Delamuraz.

On Thursday, 7 May and on Friday, 8 May 2009 two coffee breaks are provided for the congress delegates, on Saturday, 9 May 2009 one coffee break in the morning will be provided.

The coffee breaks take place in the poster exhibition area.

For conference participants the coffee breaks and lunches are included in the registration fee.
Protein

Dietary protein and bone mass accrual

R. Rizzoli, J. Bonjour, S. Ferrari, T. Chevalley (Geneva, CH)

Peak bone mass is a significant determinant of fracture risk later in life. Bone growth follows a track from birth up to peak bone mass achievement. This track is mainly determined by genetic factors, and could be influenced by dietary intakes, including mother nutrition during fetal life. During puberty, bone mass more than doubles. Peak bone mass is achieved for most parts of the skeleton by the end of the second decade. The factors contributing to the large variance in bone mass are genetics, which accounts for more than 70% of the variance, race, gender, dietary intakes, endocrine factors, mechanical forces, or the exposure to deleterious environmental influences. Nutritional intakes are able to modulate the genetic effects, as early as in utero. Mother nutritional conditions during pregnancy seem to impact BMD in offsprings far later in life. A lower femoral neck BMD has been recorded in prepubertal former preterm girls. Prepubertal girls seem to express benefits in bone mass long after the cessation of vitamin D supplements given during the first year of life. Protein intakes in children and adolescents are positively correlated to bone growth and bone mass accumulation. In prepubertal boys, the favorable effects of calcium supplements are mostly detectable in those with a lower protein intake, whereas calcium effects are barely detectable at higher protein intakes. There is an interaction between protein intakes and physical exercise on bone mass accumulation, higher physical activity impacts bone growth mostly at higher protein intake. Dietary protein intakes seem to affect bone accumulation at specific times during infancy and adolescence, possibly with skeletal site specificity, and even bone envelop selectivity. Thus, optimization of peak bone mass through a favorable conjunction of environmental factors, including nutrition, with sufficient protein, could be considered as an efficient long-term primary prevention of osteoporosis in the elderly. The upper limit of safety for dietary protein during bone mass accrual remains to be established.
Introduction: There has been much controversy as to the effect of dietary protein on bone health. Protein should be beneficial for bone health by increasing IGF1 production (and Ca absorption) but its sulphur amino acid content may lead to increased calciuria via acidosis, which may be detrimental. To address this controversy, we have completed the first systematic review/meta-analysis of dietary protein and bone health indices.

Materials and Methods: MEDLINE (January 1966-September 2007) and EMBASE (1974-July 2008) were searched. Studies investigating subjects with a pre-existing medical condition, animals, children, and pregnant or lactating women as well as studies involving only indirect measures of bone health were excluded. Sixty-one studies were included in the systematic review, including thirty-one correlational studies, eleven fracture risk studies and nineteen intervention studies. All r values from correlational studies were pooled by outcome. Intervention studies examining BMD, bone markers and fracture risk were pooled in the meta-analyses.

Results: In correlational studies, all pooled r values for BMD and BMC for radius, hip, and lumbar spine were significant and positive. For BMD, pooled r values (+/-95% CI) at the radius were 0.13 (0.07, 0.17), at the hip 0.12 (0.09, 0.15) and at the lumbar spine 0.14 (0.10, 0.20). The % of BMD explained by protein intake was therefore 1-2%. For BMC, pooled r values (+/-95% CI) at the radius were 0.15 (0.08, 0.22) and at the lumbar spine 0.29 (0.20, 0.38). For osteocalcin, deoxypyridinoline and hydroxyproline the pooled r values (+/-95% CI) were 0.005 (-0.06, 0.07), -0.226 (-0.41, -0.05) and -0.07 (-0.19, 0.05) respectively. In the intervention studies meta-analysis, a significant positive effect of all protein supplementation was found for BMD (WMD (fixed) = 0.02 (0.00 to 0.04, p=0.04), but no significant effect was found for bone markers (SMD (random) = 0.51 (-0.10 to 1.11). An overall significant effect was found for soy protein (SMD (fixed) = 0.11 (0.03 to 0.20, p=0.009) but not for milk basic protein (MBP) (SMD (random) = 0.48 (-0.12 to 1.07, p=0.11)). Last, for fracture risk no significant effect was found on relative risk (RR) of hip (RR (fixed) = 0.97 (0.91 to 1.04, p=0.40)) or forearm fracture (RR (random) = 1.11 (0.90 to 1.37, p=0.32)).

Discussion: Our review has found no evidence of a detrimental effect of protein on the skeleton and the findings support consumption of a diet containing mixed protein.
Protein

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Folate, vitamin B12, homocysteine methylenetetrahydrofolate reductase C667T polymorphism to bone mineral density in Saudi postmenopausal women

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Objectives: To assess the relationship between plasma folate, vitamin B12 and total homocysteine (t-Hcy), together with methylenetetrahydrofolate reductase (MTHFR) C667Y polymorphism with bone mineral density (BMD) in Saudi postmenopausal women.

Subjects and Methods: A total of 576 Saudi postmenopausal women (50-67 years) who were randomly selected and living in Jeddah area were studied. Restriction fragment length polymorphism was used for genotyping of MTHFR polymorphism. Plasma levels of folate vitamin B12 and t-Hcy were measured together with BMD of the spine (L1-L4) and hip (determined by DXA technique) and other clinical characteristics among MTHFR genotypes (CC, CT and TT) were also examined. Pearson’s correlations were used to assess the correlation between BMD values with variables including MTHFR genotypes, vitamin B12, log plasma t-Hcy, age, years since menopause, BMI and PTH. Women were classified into three groups according to CC, CCT and TT genotypes. Chi-square statistics were applied. ANOVA was used for comparison of variables among the MTHFR genotypes.

Results: BMD of the spine (L1-L4) (r = - 0.37, P < 0.001) and that of hip (r = 0.35, P < 0.001) exhibited significant negative correlations with log plasma tHcy and positive correlations with plasma folate [r = 0.26, P < 0.001 for spine (L1-L4); r = 0.29, P < 0.001 for hip], with no evident correlations between MTHFR polymorphism and BMD values studied. Adjustment for folate and vitamin B12 removed the relationship. Age (7.3%) and plasma folate (18.8%) contributed significantly to the prediction of variation in plasma tHcy. Plasma folate contributed significantly to the variation in BMD of the spine (L1-L4) and that of the hip.

Conclusions: Hyperhomocysteinemia related to folate deficiency but without significant contribution by MTHFR polymorphism, independently was associated with decreased BMD values which may contribute to the pathogenesis of osteoporosis in Saudi postmenopausal women.
Calcium (Part II)

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Calcium supplementation plays a positive role in bone and body composition in Chinese adolescents

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Objectives: To evaluate the effect of calcium supplementation on bone mineral accretion and body composition in Chinese adolescents.

Methods: A double-blind, randomized, controlled trial lasting for 24 months was conducted in 269 Chinese healthy adolescents (13-17 years old) living in suburb of Beijing, China. They were randomly assigned to four groups and received calcium carbonate tablets with elemental calcium at 63 mg/d, 354 mg/d, 660 mg/d, and 966 mg/d, respectively. Bone mineral content (BMC), bone mineral density (BMD) at total body, lumber spine and forearm, and body composition were measured by dual-energy X-ray absorptiometry. Biochemical indicators included Bone-specific Alkaline Phosphatase (BAP) and Tartrate Resistant Acid Phosphatase (TRACP-5b). Information on dietary intake and physical activity were collected with questionnaires.

Results: According to actual total calcium intakes covering supplementation and background dietary intake, all subjects were re-classified as three groups with total calcium intakes 386 mg/d (Group 1), 629 mg/d (Group 2) and 984 mg/d (Group 3), respectively, on average. After supplementation, BMC at total body in Group 2 (2464 g) or Group 3 (2437 g) were about 143 g or 116 g higher than that in Group 1 (2321 g) in boys after adjusted for the bone mass and pubertal stage at baseline, physical activity time and energy intake in two years (P<0.05). In boys, lean body mass and body weight of Group 2 (49.1 kg, 62.3 kg) and Group 3 (48.8 kg, 61.7 kg) were significant higher than Group 1 (46.7 kg, 58.9 kg) after adjustment (P<0.05). However, no significant differences between groups were observed in girls after supplementation. The differences between boys and girls on BMC and body composition indices were not significant in the same calcium supplemented groups. In multivariable regression, gender, puberty development, physical activity and calcium intakes were the most important influence factors for BMC retention at total body in Chinese adolescents (Rc2=0.429), with negative effect of puberty development and positive effect of physical activity and calcium intakes.

Conclusions: Calcium intake more than 629 mg/d lasting for two years improves growth of total body BMC, lean body mass and weight in Chinese pubertal boy, compared to lower calcium intake.
Effect of high calcium and vitamin D diets on changes in body fat, lean mass, and bone mineral density by self-controlled dieting for 4 months in young Asian women

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Objective: To investigate whether increased intake of dairy calcium and vitamin D affect body fat, lean mass, and bone mineral density (BMD) during moderate weight reduction in normal weight Asian young women who have habitual low calcium intake.

Subjects: One hundred female students with BMI of below 30 kg/m² between the ages of 18 to 37 years who were eager to be slender as many young women are.

Design: Subjects were randomly assigned to a glass of milk (more than 200 ml/day, n=52) before dinner or free intake (control, n=48) group, and were advised to consume a moderately energy-restricted diet and increase physical activity for 4 months by registered dietitians. All of them had to keep diary of body weight, dairy intake, physical activity, and any other changes affecting body weight for 4 months. Body composition (body fat, body lean mass) and BMD (L2-L4, femur neck) by dual-energy X-ray absorptiometry (DXA), blood pressure, serum glucose, and lipid profiles were measured at baseline and after 4 months.

Results: Moderate energy restriction for 4 months resulted in significant decreases in weight (-0.9 +/- 1.8 kg), L2-L4 BMD, waist and hip circumference, and blood pressure in both of the control and milk groups to the same extent. However, significant decrease in body fat (-1.2 +/- 2.6 kg) and increase in lean mass (0.3 +/- 2.0 kg) were observed only in the milk group. Changes in lean mass were correlated with changes in L2-L4 BMD (p=0.05) and the highest quartile of lean mass gain of the subjects did not indicate any decrease of L2-L4 BMD in the milk group. The subjects had more intake of milk than 200 ml/day significantly decreased body fat (-1.8 +/- 2.9 kg) than those who had less milk intake. The decrease in body fat mass was strongly correlated with the increase in body lean mass both in the milk (r=-0.79) and control (r=-0.76) groups, and moreover, the significantly higher correlation coefficient (r=-0.85) was observed in the subjects who had higher intake of vitamin D (>=4.7 microg/day; median) than the lower intake of vitamin D (r=-0.68).

Conclusion: Intake of more than just a glass of milk (>200 ml/day) and higher intake of vitamin D should accelerate the decrease in body fat and increase in lean mass as a threshold manner during dieting in young Japanese women who habitually have low intake of milk about 100 ml/day. These results suggest that young women should take more dairy and vitamin D during dieting for losing fat mass without decreasing BMD.
Seasonal differences in mineral homeostasis and bone metabolism in response to oral phosphate loading in older northern Chinese adults

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Vitamin D deficiency in older people has been recognized as an important factor influencing skeletal integrity. We recently explored ethnic differences in bone and mineral metabolism by 5 days of oral phosphate (P) loading to stimulate parathyroid hormone (PTH) secretion in older British, Chinese and Gambian adults. This study was conducted in winter and then repeated in summer. Seasonal difference in vitamin D status was only found in the Chinese group. The aim of this study was to examine whether bone metabolism in response to P loading in the Chinese group differs in the two seasons.

Thirty healthy older people aged 60-75 (15 men and 15 women) were studied in Shenyang, northern China. 2x1g elemental phosphorus was given for 5 days (Phosphate-Sandoz). Blood and urine samples were collected before and 2h after P dose on days 1, 4 and 5 and on a control day. The induced changes (%) in plasma P (pP), ionized calcium (iCa), PTH, osteocalcin, C-telopeptide of type 1 collagen (CTX) and urinary P/creatinine (P/Cr) 2 hours after P dose and over 5 days (in fasting samples before day 5 P dose) were examined.

Baseline mean 25-hydroxyvitamin D concentration (nmol/l) was lower in winter (33.2) than in summer (58.8, P<0.01). At 2 hours after P loading, seasonal differences were found for the changes in biochemical markers (mean %change of days 1, 4 and 5 from baseline). In winter, increases in pP (33.1%), PTH (21.9%), osteocalcin (11.7%) and CTX (15.1%) and decrease in iCa (-2.4%) were clearly observed and significant (P<0.01) whereas in summer only small and non-significant changes were found (pP 9.5%, PTH 8.2%, osteocalcin -4.3%, CTX 1.5% and iCa -0.2%). Significant increase in urinary P/Cr was observed both in winter (82.9%, P<0.01) and summer (65.7%, P<0.01). On day 5, a greater increase in P/Cr was found in winter (92.1%) than in summer (64.6%, P<0.01) and the increase in PTH was significant in winter (21.6%, P<0.01) but not in summer (8.0%). No significant changes were found for pP, iCa and bone makers in fasting values on day 5.

These data indicated that the perturbations in Ca and P homeostasis and bone metabolism induced by P loading were found at 2 hours after P loading but not over 5 days and were only observed in winter but not in summer. This may suggest that in this study vitamin D status may be important for bone to cope the imbalance of nutrients induced. The implication to bone health in a longer term should be investigated.
Vitamin D deficiency, when severe and longstanding, causes mineralisation defects and osteomalacia. In an earlier stage, vitamin D deficiency leads to lower calcium absorption, secondary hyperparathyroidism, and bone loss. Treatment with vitamin D and calcium can prevent fractures. Vitamin D status can be assessed by measuring the serum 25-hydroxyvitamin D (25(OH)D) level which should be higher than 50 nmol/l. Many clinicians and researchers favour higher levels e.g. above 75 nmol/l. Risk groups for vitamin D deficiency are persons who do not come outside, who have a dark skin, or wear a veil, and pregnant or lactating women, and institutionalised elderly.

Many epidemiological studies have shown a negative relationship between serum 25(OH)D and the serum parathyroid hormone (PTH) concentration. The serum 25(OH)D level where serum PTH starts to increase varies between different studies, from 30 to 78 nmol/l or higher. Recent studies did not show a deflection point below 100 nmol/l. For example, in the Longitudinal Aging Study Amsterdam (LASA) serum PTH appeared still to decrease when serum 25(OH)D was over 100 nmol/l. Serum 25(OH)D also related negatively to markers of bone turnover and bone mineral density in LASA. Urine deoxypyridinoline and serum osteocalcin, markers of bone resorption and bone formation respectively, increased when serum 25(OH)D was lower than 40 nmol/l. Several large epidemiological studies also showed a positive relationship between serum 25(OH)D and bone mineral density (BMD). In the NHANES III, BMD increased up till a serum 25OH(D) of 90 nmol/l. In LASA and the bazedoxifene trial, BMD in the hip increased up till serum 25(OH)D of 50 nmol/l. Although the increments were small, BMD might be 4-5% higher when increasing serum 25(OH)D from 15 to 75 nmol/l.

Several randomized double blind clinical trials have demonstrated that vitamin D and calcium treatment may decrease the incidence of fractures. Recent meta-analyses show that the effect is more marked in older populations (>80 yrs), in institutionalized vs community dwelling elderly and with vitamin D 800 IU instead of 400 IU per day. Although the general opinion favours vitamin D supplementation in older persons, there is no consensus whether this should be given once per day or in equivalent doses per week, per month, per 3 months or at even longer time intervals. Some studies suggests that high doses at longer time intervals are less effective. Fortification of food, e.g. dairy products, can improve vitamin D status in the whole population and needs more attention.
Maternal vitamin D status determines volumetric bone mineral density of the newborn


Vitamin D regulates 3% of the human genome, including effects on bone health throughout the life. Maternal vitamin D status may programme skeletal development. The objective of this study is to determine the association of maternal vitamin D status with volumetric bone mineral density of their newborn.

Subjects and Methods: Pregnant women (N = 98) participated in a semi cross-sectional study in a birth hospital in late autumn 2007. The mean (SD) values for age, body mass index before pregnancy, pregnancy weight gain and total vitamin D intake, in mothers were 31 (4) years, 23.5 (3.7) kg/m², 13.1 (4.3) kg and 14.3 (5.8) μg, respectively. The mean characteristics of the newborn birth weight, height, duration of the pregnancy according to gender were for girls (N = 46) 3470 (480) g, 50 (2) cm, 283 (9) d and for boys (N = 52) 3680 (390) g, 51 (2) cm and 285 (8) d, respectively. First trimester, postpartum and the umbilical cord samples were analyzed for serum 25-hydroxy-vitamin D (25-OHD) and parathyroid hormone (PTH). Volumetric bone mineral density (BMD) was measured by pQCT at the 20% site of the newborn tibia on an average 10 (11) days postpartum. Bone contour was analyzed with a single threshold of 180 mg/mm3 for the detection of total bone BMD, BMC and CSA.

Results: The mean S-25-OHD was 43.7 (14.5), 49.3 (14.3) and 50.8 (13.9) nmol/l, during first trimester, postpartum and in umbilical cord, respectively. The newborns were divided into two groups: low group with mean maternal vitamin D status below 42.6 nmol/l and high group with mean maternal vitamin D status at least 42.6 nmol/l. Mean maternal postpartum PTH was 3.38 (1.96) pmol/l, which correlated inversly with 25-OHD, r = -0.283, (p < 0.001). A correlation was found between maternal vitamin D status and newborn tibian CSA, r = 0.227, (p < 0.05). Newborn in the low group were heavier (p = 0.03) and 64 % boys. Tibia BMC was found to be 0.046 (95% CI 0.010-0.081) g/cm higher (p = 0.01) and CSA 11.8 (95% CI 1.7-21.8) mm² bigger (p = 0.02), but no difference in BMD, in the high group compared with the low group. These results were adjusted for newborn weight, height, gender, the durance of gestation and age at the measurement.

Conclusions: Current Nordic recommendation is inadequate for pregnant women. Newborn with lower maternal vitamin D status had an average 13.5 % lower BMC and 15.6 % smaller CSA in tibia, but no difference in vBMD compared to newborn with higher maternal vitamin D status.
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Metabolomic studies identify true responders from non-responders to vitamin D supplementation in postmenopausal women

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A high prevalence of hypovitaminosis D in the elderly population, suggest genetic inter-individual variability in handling micronutrients. We undertook a metabolomics study in morning fasting urine samples, in normal postmenopausal women before and after supplementation with calcium and vitamin D, using serum parameters of calcium homeostasis to determine response and matched these with urinary patterns of unique metabolites determined by NMR spectroscopy. 112 postmenopausal women (69 ± 10 yrs) gave informed consent to giving a blood and morning fasting urine sample before and after 3 months and age matched to receive either oral 800 units of vitamin D and 1200mgs calcium or no supplementation. Serum biochemical profile included calcium and albumin, vitamin D and PTH. Urinary calcium and creatinine were measured and putative NMR spectra were recorded in triplicate in a fully automated manner on a Varian UNITY 400 MHz spectrometer using a proton NMR set-up operating at a temperature of 293 K. The spectra were processed using the standard Varian software and converted to a data file suitable for multivariate analysis applications (MVDA). Small differences of comparable signals in different NMR spectra were aligned and respective datasets were used for MVDA in Matlab. Complete data was obtained in 47 subjects. Data was normalized, centred and scaled. Significant changes in calcium, PTH and Vit D, differentiated responders (22) from non-responders (14) and controls (11) at 3 months, despite good compliance. The NMR data show distinct patterns in distinguishing controls, responders & non-responders. Segregation was recognisable even before treatment commenced. Fingerprints suggests that folate and vitamin B metabolism are implicated in Ca/VitD status and response to supplementation. Deficiency, and how micronutrients interact in this population would be premature without larger studies to include genetic polymorphisms to develop tests for patients who respond to supplementation and target therapy appropriately.
**Vitamin D (Part II)**

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Effects of a vitamin D and calcium supplementation on blood pressure and heart rate in community-dwelling older individuals – a randomized prospective double-blind study

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At present there are only few studies available investigating effects of vitamin D and calcium supplementation on parameters of heart function. This prospective study was undertaken to test the influence of latitude, seasonal variations, possible threshold effects and duration of vitamin D efficacy after cessation of therapy. 242 healthy male and female subjects over 70 years of age and a 25-OH-D3 serum level below 75 nmol/l were recruited in Bad Pyrmont and Graz and were randomly assigned to two treatment groups: one receiving 1000 mg Calcium/day (Ca) and the other 1000 mg Calcium and 800 I.U. Vitamin D (Ca+D) over 12 months. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were determined under standardized conditions every four months. Statistical evaluation was carried out using the statistics software of IDV, Gauting (Test + Estimation, Version 5.2, “CRO” Dr. Heinz, Vienna, Austria). Baseline parameters did not differ between groups.

We performed an intention-to-treat analysis and found the following results:

In the (Ca+D) group 25(OH)D increased significantly (p<0.01) from 57 +/- 20 nmol/l at baseline (BL) to 84 +/- 18 nmol/l at month 12 (M12), whereas in the (Ca) group there was no change (54 +/- 19 versus 55 +/- 18 nmol/l).

In the (Ca+D) group SBP decreased significantly (p<0.01) from 134 +/- 17 mmHg at BL to 124 +/- 14 mmHg at M12, whereas in the (Ca) group there was no change (137 +/- 17 versus 133 +/- 16 mmHg).

In the (Ca+D) group DBP decreased significantly (p<0.01) from 76 +/- 7 mmHg at BL to 72 +/- 7 mmHg at M12, whereas in the (Ca) group there was no change (79 +/- 8 versus 78 +/- 9 mmHg).

In the (Ca+D) group HR decreased significantly (p<0.01) from 74 +/- 4 beats/min. at BL to 70 +/- 4 beats/min. at M12, whereas in the (Ca) group there was no change (74 +/- 4 versus 75 +/- 4 beats/min.)

Despite a relatively high inclusion criterion for vitamin D (75 nmol/l) and independent of latitude, we observed a significant reduction of blood pressure and heart rate after supplementation with vitamin D and calcium. This effect of nutritional supplements may be comparable to the efficiency of hypertensive drugs.
Dietary patterns and bone health

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Nutritional research on bone health has focussed on the nutrients calcium and vitamin D; although more recently there has been interest in the role of protein, and fruit and vegetables. It is likely that there will be interactions between nutrients and food components, and dietary patterns may be helpful in elucidating what diet might be protective of bone health.

Early postmenopausal women (n=3238) from the Aberdeen Prospective Osteoporosis Screening Study (APOSS) visited our unit in 1998-2000 for bone mineral density (BMD) scans of the lumbar spine and hip, and provided second early morning fasted urine samples for analysis of bone markers (free pyridinoline and deoxypyridinoline). Diet was assessed by a validated food frequency questionnaire comprising 116 food and drink items from which 35 food groups were generated. Two methods (Principal components analysis and Partial Least Squares Regression, PLS) were used to examine the relationship between dietary pattern and markers of bone health. Both approaches were also used to examine the role of meal timing and fasting periods.

Principal component analysis identified 5 factors accounting for 26% of the total variance. Three patterns were associated with markers of bone health: ‘healthy’, ‘processed food’ and ‘junk food’. The first diet was associated with reduced bone resorption, the second and third diets were associated with reduced BMD. Two other patterns showed no association. By PLS, fruit, tea and yoghurt were beneficial to BMD whereas wine, sauces/jam and vegetable intakes were associated with decreased bone resorption. Preliminary work has generated patterns of meal timings.

The dietary patterns generated with these statistical methods confirm results found with nutrients and key food groups. In addition, similar exploratory approaches may help define the focus of future research. In the longer term, dietary derived guidelines may be translated more easily into clear public health advice, compared to advice based on recommended daily amounts of nutrients.
Nutritional factors that influence change in bone density and stress fracture risk among young female cross-country runners


Limited data are available on the impact of diet on skeletal health in female endurance athletes. The objective was to identify the nutritional factors associated with change in bone density and stress fracture risk among young female runners. The study population was 125 female competitive distance runners aged 18-26 years who had participated in a 2-year randomized trial of the effect of oral contraceptives on bone health. Participants completed a food frequency questionnaire at each visit. Bone mineral density and content (BMD/BMC) of the spine, hip, and total body were measured annually by dual x-ray absorptiometry. Participants were followed approximately 2 years for stress fracture occurrence. Relationships between nutrients or beverages and stress fractures (by adjusted hazard ratios) and annual rates of change of BMD and BMC (by linear mixed models) were evaluated with control for clinical assessment site, group to which a participant was randomized, menstrual status at baseline, spine bone density, age and stress fracture history prior to enrollment. Dietary patterns were derived from a reduced rank regression method and were evaluated in relation to stress fracture incidence and the rate of change in BMD or BMC. The average age at baseline was 22 years, 83% were white, 33.6% reported menstrual irregularity and about one-third reported a prior stress fracture. Seventeen participants had at least one stress fracture during follow-up. Higher intakes of calcium, skim milk and dairy products were associated with lower rates of stress fracture. High dairy and low fat consumption was associated with a 68% reduction in stress fracture. Modest increases in total body BMD and BMC were associated with higher intakes of skim milk, dairy foods, calcium, animal protein and potassium. Small increases in hip BMD were associated with higher intakes of calcium, vitamin D, skim milk, dairy foods, potassium, and a dietary pattern of high dairy and low fat. In young female runners, low fat dairy products and the major nutrients in milk (calcium, vitamin D, and protein) were associated with greater bone gains in young women and a lower stress fracture rate. Potassium intake was also associated with greater gains in hip and total body BMD. Therefore, an overall healthy diet, with low fat milk to provide adequate calcium and vitamin D and sufficient in fruits and vegetables may provide the greatest skeletal benefit to cross-country runners.
Aging is related to declines in physical performance and bone density and these factors combined lead to an increased risk of fracture. Poor physical performance in the elderly has been related to an increase in the risk of falls and osteoporosis related fractures. Serum vitamin D has been shown to relate to improved physical performance. However, the impact of dietary intake on physical performance is not well understood. Foods are not consumed in isolation; therefore an analysis that take into account the interactions among food components may help determine an ideal dietary pattern (reduced-rank regression (RRR)). In this study, 1155 community dwelling elderly (age > 65 years) in New York provided dietary data and were assessed for the time to complete two 4-meter walks and 5 chair stands. In addition, each participant provided information on his or her level of recent physical activity. Based on published data evaluating physical performance, we determined that calcium, magnesium, potassium and vitamin D were the nutrients likely to be related to physical performance. Using RRR we calculated the dietary patterns (linear combinations of 33 food groups) based on their ability to explain variation in the above four nutrients. The association of these RRR-derived dietary patterns with walk speed, chair stands, and self reports of physical activity was then determined using analysis of covariance controlling for age, gender, body mass index, a comorbidity index, ethnicity, and caloric intake. There was no association between any dietary pattern and self-report of physical activity. However, average walk speed was faster (5.7+0.13 sec) in those individuals with a dietary pattern where individuals consumed high amounts of fruits, vegetables, legumes and low fat dairy as compared to those individuals with a diet that was lower in the consumption of these foods (6.1+ 0.15 sec; p<0.05). Similarly, time to complete a series of 5 chair stands was significantly faster in individuals with the same dietary pattern described above as compared to those with lower intakes of these foods (p<0.05). The simultaneous consideration of multiple nutrients can aid in the identification of a dietary pattern that relates to improved physical performance measures. We conclude that a diet that is high in fruits, vegetables, legumes and low fat dairy products is related to improved physical performance. This in turn could lead to a reduction in falls and fractures.
Impact of hesperidin, a citrus flavanone, in improving bone metabolism in age-related models of bone loss

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Among the nutritional strategies for prevention of osteoporosis, fruits and vegetables may play a role as well as some of their active components such as flavonoids. In this context, the effect of flavanones, a major class of flavonoids found in citrus fruits is of particular interest to us. We therefore carried out a series of preclinical studies testing the effect of hesperidin, the major flavanone found in orange peel and in pressed orange juice, on bone metabolism.

In a first study, the effect of 3 months supplementation of hesperidin was studied in ovariectomized (OVX) rats from 3 to 6 months (model of postmenopausal induced bone loss) and also in intact animals of the same age. The results showed that hesperidin (0.5% in the diet) was able to improve bone mass in intact rats of 3 months and protect against bone loss in the OVX rat of 6 months. In parallel, dose-response studies were carried out in intact animals of 3 months and showed that the minimal dose was 0.25%.

In a further study, we compared the bioavailability and efficacy of native hesperidin versus its intestinal metabolite hesperetin-7-glucoside (generated by the enzyme beta-rhamnosidase) and showed that at equivalent doses, hesperetin-7-glucoside was more bioavailable and more efficient in inhibiting the OVX induced bone loss in rats of 6 months as indicated by measures of BMD, bone biomarkers and bone strength.

Recently, we carried out a study in 20 month-old male, intact rats that were supplemented with hesperidin or naringenin (principal flavanone in grapefruit) vs control diet and showed that hesperidin was more potent than naringenin in maintaining bone mass with age.

In light of these promising results obtained in the various animal studies, nutritional intervention studies are now underway to test the ability of hesperidin (500 mg/day) to protect against postmenopausal bone loss in a 2 year study.

In conclusion, certain components from fruits and vegetables, such as flavonoids like hesperidin may contribute to a positive effect on bone health and thus be part of an integral strategy together with calcium, vitamin D and other micronutrients to help protect against age-related bone loss.
Percentage lean body mass is lower with a higher dietary acid-base load in women aged 18 to 79 years

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Objectives: Falls are a major risk for fracture and age related decline in muscle mass may thereby contribute to falls. Bone density is also a predictor of fracture risk and muscle mass has been related to bone density. Therefore, it is important to identify factors that affect muscle mass.

Besides the known effects of age and physical activity, nutrition has the potential to influence maintenance of muscle mass. Metabolic acidosis is related to a decline in muscle mass in renal failure, and metabolic acidosis affects protein metabolism by decreasing protein synthesis and increasing nitrogen excretion even in normal individuals. Thus it is possible that mild metabolic acidosis could influence muscle mass in normal individuals. The acid-base load of diet is known to influence acid-base status and so we investigated the association between dietary acid-base load (estimated as PRAL – Potential Renal Acid Load) and percentage lean body mass (LBM) in a study of female twins aged 18 to 79 years.

Methods: Lean body mass was measured using a DXA Hologic machine in 2891 female twins and converted to percentage LBM by dividing by body weight. PRAL was measured using a Food Frequency Questionnaire and divided into quartiles, and calculated using the formula:

\[ PRAL = (P \times 0.0366 + \text{protein} \times 0.4888) - (K \times 0.0205 + \text{Ca} \times 0.0125 + \text{mg} \times 0.0263) \]

Results: Intake of PRAL ranged from mean (se) -29.4 (0.22) mEq/d in Quartile 1 to mean (se) 4.84(0.22) mEq/d in Quartile 4. There was a significant trend towards a decrease in LBM with increasing PRAL (more acidic dietary intake) from 61.04 % in Quartile 1 to 60.01% in Quartile 4 (P=0.026), a difference of 1.03% (adjusted for age, physical activity and smoking habit).

Conclusion: There was a cross-sectional decrease in LBM with a higher PRAL intake and although this difference was relatively small it was significant and independent of the effects of age and physical activity. Further analyses are ongoing in this twin study to determine the heritable and familial determinants of LBM.

The acid-ash hypothesis of osteoporosis: a meta-analysis of the effect of dietary acid-ash load on calcium balance


The acid-ash hypothesis posits that protein and grain foods produce a diet acid load, net acid excretion, increased urine calcium, and release of calcium from the skeleton, leading to osteoporosis.

The objectives of this meta-analysis were to assess the effect of changes in net acid excretion, by manipulation of healthy adult subjects’ acid-base intakes, on urine calcium, calcium balance, and a marker of bone metabolism, N-telopeptides. This meta-analysis was limited to studies that used superior methodological quality for the study of calcium metabolism.

Methods: Literature was identified through computerized searches. Studies were only included in meta-analyses if they had superior methodological quality. Superior methodological quality was defined as: subjects were randomized to the interventions and recommendations of the Institute of Medicine’s Panel on Calcium and Related Nutrients were followed, such as adaption of the subjects to the study calcium intakes for seven or more days. Regression analysis was weighted by the number of subjects in each study.

Results: Five of sixteen studies met the inclusion criteria. All of the included studies altered the amount and/or type of protein. All of the studies of protein quantity compared protein intakes that were moderate and/or high, and none of the studies assessed the effect of low protein intakes. Despite a significant linear relationship between an increase in net acid excretion and urinary calcium (p < 0.0001), there was no relationship between a change of net acid excretion and a change of calcium balance (p = 0.38), power = 94%. There was no relationship between a change of net acid excretion and a change in the marker of bone metabolism, N-telopeptides (p = 0.95).

Conclusion: This meta-analysis does not support the concept that the calciuria associated with higher net acid excretion reflects a net loss of whole body calcium. In studies of altered protein intakes (amount and type of protein) changes in urine calcium do not accurately represent changes in calcium balance. This meta-analysis does not address the question of the effect of low protein intakes on calcium balance. There is no evidence from superior quality balance studies that increasing the diet acid load promotes reduced calcium balance and thus skeletal bone mineral loss and osteoporosis.
Population-based studies have shown beneficial effects of fruit and vegetables on markers of bone health, however it is unknown which specific fruit and vegetables may be involved. The aim of this study was to use a novel statistical method to model relationships between intakes of fruit and vegetables and markers of bone health, and show which particular fruit and vegetables are associated with bone health.

The subjects were recruited in 1990-3 for the Aberdeen Prospective Osteoporosis Screening Study, and the majority of them (n=3238) returned 6.3 ± 0.6 y later (mean age (SD) at baseline: 54.7 (2.2) y). At the return visit they had bone density scans of the lumbar spine (LS) and hip (FN) (Norland XR26/36 DXA), provided second early morning fasted urine samples for analysis of bone markers (free pyridinoline and deoxypyridinoline). Diet was assessed by a validated food frequency questionnaire from which information on intakes of 28 fruit and vegetables was extracted. Partial Least Squares regression (PLS) was used to model the relationships between the variability of both the dietary and bone variables simultaneously.

Coefficients plots revealed that intakes of tomatoes, salads, berries, capsicum peppers and green vegetables were associated with greater LS and FN BMD. Decreased bone resorption was associated with tomatoes, berries and fruit juice intakes, whereas increased bone resorption was associated with intakes of tinned fruit and root vegetables. The Variable Importance for the Projection plots showed that root vegetables (detrimental to bone), berries, apples and salad (beneficial to bone) predicted the greatest variation in BMD, whereas tomatoes and salads predicted the greatest change in bone resorption.

This is the first time that PLS has been used to examine relationships between diet and bone health. Unlike principal components analysis (which only uses the independent variables), it uses both the independent and explanatory variables to reveal relationships. This analysis helps direct research by indicating which foods, and hence nutrients, may be involved in maintenance of good bone health. Future work will examine the relationships between other food groups and indices of bone health.
Calcium absorption from fortified ice-cream formulation compared with calcium absorption from milk

(Vlaardingen, NL; Bedford, Norwich, UK)

Background: Optimal bone mass in early adulthood is achieved through appropriate diet and lifestyle, thereby protecting against osteoporosis and risk of bone fracture in later life. Calcium and vitamin D are essential to build adequate bones, but calcium intakes of many population groups do not meet the dietary reference values. Additionally, changes in dietary patterns are exacerbating the problem, thereby emphasizing the important role of calcium-rich food products. We have designed a calcium fortified ice cream formulation that is lower in fat than regular ice cream which could provide a useful source of additional dietary calcium.

Objective: Calcium absorption from two different ice cream formulations was determined in young adults and compared to milk.

Subjects/Design: Sixteen healthy volunteers (25-45y), recruited from the general public of the Netherlands, participated in a randomized, reference controlled, double-blind cross-over study in which two test-products and milk were consumed with a light standard breakfast on three separate occasions: (A) a standard portion of ice cream (60 g) fortified with milk minerals and containing a low level (3%) of butter fat, (B) ice cream (60g) fortified with milk minerals and containing a typical level (9%) of coconut oil, and (C) reduced fat milk (1.7% milk fat) (200 mL). Calcium absorption was measured by the dual-label stable isotope technique.

Statistical analysis: The effects on calcium absorption were evaluated by analysis of variance.

Results: Fractional absorption of calcium from the 3% butterfat ice cream, 9% coconut oil ice cream and milk was 26 ± 8 %, 28 ± 5%, and 31 ± 9% respectively and did not differ significantly (P = 0.159).

Conclusions: The results indicate that calcium bioavailability in the two calcium fortified ice cream formulations used in this study is as high as milk indicating that ice cream may be a good vehicle for delivery of calcium.
Alkalinity of mineral water alone does not inhibit bone resorption

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Aims: There is a growing belief that the Western diet may be a risk factor for osteoporosis through excess acid supply. Certain mineral waters may balance the excess acidity by providing bicarbonate. The aim of our study was to assess the effect of a daily intake of 1.5 litres of a sodium-bicarbonated mineral water (relatively low in calcium) compared to a low-mineral water, on bone markers in a sample of young women on a balanced controlled diet.

Methods: In a double crossover design, twenty-two female dieticians (aged 30.1 +/- 5.5, BMI 21.5 +/- 2.3) were randomly assigned to a sequence of drinking two mineral waters with an equal calcium content, a low-bicarbonated mineral water (Water A) and a high-sodium-bicarbonated water (Water B). The sequence was as follows: Group A: two weeks on Water A, 2 weeks wash-out, 2 weeks on Water B for half the group (n=11) and Group B: two weeks on Water B, 2 weeks wash-out, 2 weeks on Water A (n=11). Measurements of blood and urine electrolytes were performed at baseline and after 2, 4 and 6 weeks, after 12 hours fasting. In addition, urinary pH and bicarbonate, serum PTH and serum C-telopeptides (CTX) were measured at the same time.

Results: There were no significant differences between the two groups for all the variables at baseline, except for height (p=0.02). In both groups, the values of the 2h fasting urine and of the 24h urinary excretion of bicarbonate, sodium and pH were significantly higher (p<0.05) after consumption of Water B compared the values after consumption of Water A. CTX/Cr and serum crosslaps stayed stable and showed no significant differences during the trial.

Conclusion: The increase in bicarbonate and urine pH values after drinking water B, showed the expected impact of water B on the acid-base metabolism. However, the sodium-bicarbonated mineral water did not lead to the expected decrease of bone resorption markers in this sample of healthy young women. This could be explained by an insufficient study time (2 weeks for each water), although in a previous study a significant effect on bone resorption was observed already after 2 weeks with Calcium- and Bicarbonate-rich water, or by the relatively low calcium content of water B. Future studies on a longer period are required.
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Is there a correlation between oral calcium intake and bone density?

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Introduction: Since performing the „Osteoporose Kompaktkur“ in our Rehabilitation Centre there is theoretical & practical teaching regarding nutrition including estimation of oral Calcium intake and Bone Density measurement (DEXA). It was the aim to check for a correlation between oral Calcium intake and bone density.

Methods: The study, performed March 2006 – March 2007, includes 127 patients (mean age 69.3 a, 26 male (68.0 a), 101 female (69.6 a)) – they all had a DEXA Lunar Prodigy measurement at the spine & hip. We estimated the daily Ca intake by questionnaire being analysed by a special nutritional software (Prodi 5.4 basis). The statistical analysis was performed by “Linear regression by the least squares”.

Results: There was no correlation between Ca intake and t-score of spine and “total” hip (n.s.) also, as already known:
– strong correlation between t-score of spine and “total” hip;
– negative correlation between age and bone density;
– higher bone density in males than females (p < 0.001 lumbar spine, p < 0.003 “total” hip).

Conclusion: 1. Regarding risk factors of osteoporosis the sole estimation of Ca intake is irrelevant.
2. Nevertheless we’ll continue to estimate the oral Ca intake, as it is an helpful measure regarding Ca & Vit D medication (combination of both!).
3. There will be more results in the future (data already collected) regarding the influence of protein and phosphate intake in combination with Ca on the bone density.

Acknowledgement: Thanks to Dr. Werner Möhrke for statistical analysis.
High sodium chloride intake might contribute to muscle wasting via low-grade metabolic acidosis

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Osteoporosis is a multifactorial musculoskeletal issue: factors that influence muscle likewise affect bone metabolism. Anyway, muscle degradation is caused by mechanical unloading but also by several other environmental stimuli, e.g. in renal failure metabolic acidosis has been linked to muscle wasting. We have recently shown that a high sodium chloride (NaCl) intake induces low grade metabolic acidosis. We therefore hypothesized that high NaCl intake exacerbates disuse-induced protein losses. Eight healthy male subjects (mean age 26.25 ± 3.5; mean body weight: 78.5 ± 4.1 kg) participated in a 14-day crossover bed rest study in the metabolic ward of the DLR – Institute of Aerospace Medicine, Cologne, Germany. Each of the study phases lasted 22 days (5 days adaptation, 14 days bed rest and 3 days recovery). During the bed rest phases every subject received a low NaCl diet (0.7 mEq/kg/day) in one phase and a high NaCl diet (7.7 mEq/kg/day) in the other one. The diet was individually tailored and weight-maintaining with a constant protein intake of 1.3 g protein/kg/day. Blood gases were taken on predefined times. Nitrogen balance was calculated from the difference between nitrogen intake and excretion in 24h urine. The high NaCl intake during bed rest induced a low grade metabolic acidosis (pH: high NaCl: 7.419 ± 0.017; low NaCl: 7.426 ± 0.018, (p = 0.061); bicarbonate: high NaCl: 25.21 mmol/L ± 1.14; low NaCl: 26.4 mmol/L ± 1.36, (p<0.001)) and a more negative nitrogen balance (high NaCl: -1.26g/d ± 2.3; low NaCl: -0.47g/d ± 2.3, (p<0.001)). Our results indicate that high NaCl intake exacerbates disuse-induced protein losses. We conclude that a high NaCl intake is a risk factor for osteoporosis not only due to its influence on bone itself but also because it induces protein wasting, most likely from skeletal muscle. Currently we are investigating if the observed low grade metabolic acidosis with high NaCl intake might be the reason for increased protein losses.
P45

Vitamin D status and the association with forearm bone mass in Chinese Tibetan and Han nationality children and adolescents

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Objective: To evaluate the vitamin D status and the association with distal and proximal bone mass in Chinese Tibetan and Han nationality children and adolescents.

Methods: In a cross-sectional study, 718 healthy subjects aged 7-18 years were randomly recruited in A Ba Zang Qiang Autonomous Prefecture, Sichuan Province, China, with about 15 subjects per nationality, gender and age. Their body mass of non-dominant forearm were measured by peripheral Dual Energy X-ray Absorptiometry (Norland, USA). The concentration of serum 25-hydroxyvitamin D, 25(OH)D, were tested in duplicates by enzyme immunoassay (ELISA) kits (Immunodiagnostic Systems Limited (IDS), UK).

Results: The average age of subjects were 12.8±3.0 years. The average concentration of 25(OH)D were 38.7±17.2 nmol/L in boys, significantly higher than that in girls (31.3±16.6 nmol/L) in early spring (P<0.05). The percentage of vitamin D deficiency (25(OH))D <25nmol/L) were higher in girls (48.3%) than that in boys (22.5%) (P<0.05). The 25(OH)D concentration were associated with age and gender (R2=0.13), but not nationality (P<0.05) in multiple regression analysis. At the age of 14, the serum 25(OH)D concentration reached the bottom. The serum 25(OH)D concentration were significantly positively associated with bone mineral content (BMC) and bone mineral density (BMD) at proximal forearm bone mass, and bone area (BA) at distal forearm; however, these association disappeared after adjusted for gender, age and nationality.

Conclusion: The vitamin D deficiency was relatively common in early spring in Chinese Tibetan and Han nationality children and adolescents. Gender and sex, rather than nationality, had effect on serum 25(OH)D concentration. The association between 25(OH)D concentration and forearm bone mass indices were not significant.
Vitamin D inadequacy in the Jordanian female population – FiJoNOR survey

B. Masri (Amman, JOR)

1241 Jordanian females aged 20 to 89 years were interviewed in their homes. They were selected using a stratified three-stage cluster sample covering urban and rural regions in the entire country as drawn by the Jordanian department of statistics. 821 women met the study criteria and underwent dual energy x-ray absorptiometry measurement (Hologic Delphi a) as well as other laboratory investigations included 25-OH-Cholecalciferol, serum calcium & phosphorus, albumin, and TSH. For those over 50 years x-ray morphometry study of the spine had been done. All has been also surveyed for their nutrition habits, physical activity and sun exposure. Our results showed a high Vitamin D inadequacy among the studied population in the entire group despite age or social and economic status.

We think (as many studies already suggested) the importance to increase Vitamin D intake and reasonable sun exposure to reduce the harmful effect of Vitamin D inadequacy in the bone health particularly as well as the general health as shown in different studies.

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The importance of timing potassium bicarbonate supplementation to affect acid-base balance

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In dealing with the negative consequences of a low-grade-metabolic acidosis, induced partially by the western industrialized world’s nutrient composition, alkaline salts such as potassium bicarbonate (KHCO3) have shown to serve as an effective countermeasure. We have recently shown that high sodium chloride (NaCl) intake also induces a low-grade metabolic acidosis. However, timing of the alkaline salt’s application relative to a meal might lead to different responses. Therefore, the main aim of the present study was to determine the ideal time for the intake of KHCO3 relative to a sodium chloride abundant meal.

10 subjects (6 male, 4 female) completed 4 identically scheduled days of the experiment, with 1 day for the control experiment (no supplementation) and 3 days for the different interventions (supplementation of 45mmol KHCO3 before, with or after lunch, respectively). Meals and bloodgas analyses (measured parameters: pH, HCO3-, base excess (BE)) were appointed at definite times. Additionally, a questionnaire monitored any side effects of the supplementation, possibly gastrointestinal disturbances (e.g. flatulence, nausea, diarrhea).

Supplementing KHCO3 results in a more alkaline status within the normal range compared to the control (control/different times of supplementation: HCO3- 24mmol/L/26mmol/L (p=0.02); BE 0mmol/L/1mmol/L (p=0.002)) (before meal: HCO3-/BE: p=0.02/p=0.002; with the meal: p=0.02/p=0.002; after meal: p=0.003/p<=0.001). In this context pH showed significant effects in only two different times of supplementation (during meal (p=0.007), after lunch (p<=0.001)). Except for pH (p=0.01, originating from the supplementation after lunch) timing of the supplements did not lead to different results (HCO3-: p=0.24; BE (p=0.24). Regarding the side effects, subjects were most comfortable in the supplementation with the meal.

With the present study, the positive effects of a KHCO3’s administration on the acid-base balance in combination to a sodium chloride abundant meal were confirmed. In aiming to advise an ideal time of KHCO3’s- intake with the focus on all three main descriptive parameters the results make no allowance for setting an advisable time of intake. When taking into account the side effects supplementation of KHCO3 with the meal is highly appreciated.
Analysis of bioavailable phosphorus content in differently processed cereals

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Objectives: The amount of bioavailable phosphorus in different foodstuffs is unknown and is expected to vary. In Western countries the intake of phosphorus is higher than recommended which can be detrimental to bone health. To get information on bioavailable phosphorus (BP), a new in vitro method for analysis was developed. The amounts of total phosphorus (TP) were also analysed and compared to the values of Finnish food database Fineli®. We focused on the analysis of cereals.

Methods: Total and bioavailable phosphorus contents of wheat flour, rye flour, oat flakes, barley grits, barley porridge, self-made wheat sourbread, wheat bread and rye sourbread, and one bakery wheat bread and two bakery rye breads were analysed (N=5). For the BP analysis the samples were first processed by simulating the processing of chyme with alimentary enzymes and incubating at room temperature. The samples were dialyzed against water in room temperature and phosphorus analysis was made from the dialyzate by inductively coupled plasma mass spectrometry device (ICP-MS). TP analysis was also made by ICP-MS.

Results: In each sample, the amount of BP was significantly lower (P<0.05) than the amount of TP. In wheat breads the amounts of BP were about 50 % of TP and did not significantly differ from wheat flour (P=0.086 and P=0.154). In rye breads the BP part of TP was 69-78 % and in rye flour it was 45 %, and they differed significantly from each other (P<0.05). Measurement uncertainty was 6-7 %.

Conclusion: BP contents in cereals differed from TP which suggests that the estimations based on food databases do not give an accurate estimation of the phosphorus intake. This method seems to be useful for BP analysis. TP values of Fineli® seem to require evaluating. BP contents in foodstuffs need further investigation and the method should be validated against an in vivo method.
Positive correlations between vitamin D status and bone health in southern UK premenopausal women: preliminary results from the D-FINES study


Introduction: Vitamin D status has been linked to the aetiology of many chronic diseases including osteoporosis, type 1 diabetes and cancer. The impact of vitamin D status has been much investigated in older, but not younger people in Western populations. The aim of this analysis was to examine associations between vitamin D status and indices of bone health in premenopausal women living at Southern UK latitudes (51oN).

Methods: The data were from the UK FSA-funded D-FINES study (Vitamin D, Food Intake, Nutrition and Exposure to Sunlight in Southern England, 2006-2007). Vitamin D status was measured once every season over a twelve month period and bone density was measured by DXA (Hologic QDR 4500) at the lumbar spine (LS) in autumn and spring. In this preliminary analysis, data from a subset of 135 Caucasian and 50 Asian women (mean age 35y; standard deviation 6.9y) were analysed.

Results: A significant positive Pearson's correlation was found between autumn LS BMC and summer (r=0.263, p=0.002), autumn (r=0.223, p=0.014), winter (r=0.224, p=0.021) and spring (r=0.212, p=0.033) vitamin D status. Similar results were found for autumn LS bone area and summer (r=0.273, p=0.001), autumn (r=0.195, p=0.033), winter (r=0.254, p=0.009) and spring (r=0.236, p=0.017) vitamin D status. Partial correlation controlling for body mass index (BMI) found a significant positive correlation between autumn LS BMD and summer (r=0.212, p=0.015) and autumn (r=0.197, p=0.032) vitamin D status. However, only effects approaching statistical significance were found for winter (r=0.189, p=0.056) and spring (r=0.159, p=0.116).

When women were grouped by vitamin D status (<25 nmol/l; 25-29nmol/l; 30-39nmol/l; 40-74nmol/l; 75nmol/l+), analysis of covariance (ANCOVA) with BMI entered as a covariate showed a significant difference in LS BMD between the groups for autumn (p=0.002) winter (p=0.028) and spring (p=0.028) vitamin D status and a borderline significant difference for summer (p=0.057).

No significant correlation was found between PTH and LS BMC, bone area or BMD for any season (p>0.05).

Discussion: These results show a positive relationship between vitamin D status and lumbar spine BMC and bone area in all seasons of the year in premenopausal women, thus emphasising the importance of public health measures to improve vitamin D status in younger (as well as older) populations.
P50

Differences in soluble phosphorus content of foods

H.J. Karp, P. Ekholm, V.E. Kemi, C. Lamberg-Allardt (Helsinki, FIN)

Objectives: A high phosphorus intake may have negative effect on bone. However, current phosphorus intakes are not well known as the use of phosphorus-containing food additives has not been taken into consideration when establishing food composition databases. Furthermore, little is known on the absorbability of phosphorus from different foods. Measurement of soluble phosphorus content of foods may reflect absorbability of phosphorus. The objective of this study was to analyse total (TP) and soluble phosphorus (SP) content of certain phosphorus-containing foods and to compare the proportion of SP among different foods.

Methods: TP and SP content of 56 foods were analysed. TP analysis was conducted by a routine method using plasma mass spectrometry device. In SP analysis, a novel method simulating the processing of chyme with digestive enzymes was used. The percentage values of SP to TP were counted.

Results: Processed cheeses containing phosphate additives had a mean TP content of 730mg/100g, of which 65% was SP in average. In unprocessed hard cheeses the results were 710mg/100g, and 54%, respectively. In sausages the average amount of TP was 200mg/100g, of which 67% was SP. In cola drinks and beer, the percentage of SP to TP was 87-100% (13-22mg/100g). In average, legumes contained SP only 40mg/100g (19% of TP). Industrially prepared pastries containing leavening agent had a TP content of 220mg/100g, of which 79% was SP. Instead, another type of industrial pastries leavened with yeast contained 120mg/100g of TP, of which 36% was SP.

Conclusion: Absorbability of phosphorus may differ substantially among different foods. Despite high TP content, legumes may be a poor phosphorus source. In cola drinks almost all phosphorus is soluble, which supports previous information on the effective absorbability of phosphorus from phosphate additives. Highest SP content among foods analysed in this study were found in cheeses.
Osteoporosis and diabetes mellitus type 2 (DM2) may have severe health consequences, with high morbidity and mortality risks. The bone mass loss related mechanisms in DM2 are not totally clear. We have detected a relatively high prevalence of reduced bone mass (low bone mass and/or osteoporosis) in diabetic males. On the other hand, in another study, we observed a tendency for the sex steroid levels reduction along with the bone mineral density (BMD) in men over 40 years old.

Aim: Contribution to study the differences of the sex steroid levels in DM2 males with normal BMD, low BMD and osteoporosis and their relationships with BMD.

Materials and Methods: In 301 men with DM2, the BMD was evaluated (g/cm2) at the lumbar spine (L1-L4), at the hip and at the distal forearm, using the QDR Discovery W radiological densitometer (Hologic Inc.). According to the T-score obtained in at least in one of those skeletal sites, this population was divided in normal bone mass, (n=126), low bone mass (n=110) osteoporosis (n = 65) groups.

Fast blood was also collected for glycem ia, HbA1c, total testosterone (T) and 17 beta-estradiol (E2), sex horm one binding globulin (SHBG), free testosterone (FT) measurements. The BMI was also calculated.

Anova and multiple regression analysis tests were used to differentiate the several parameters (sex steroid hormones were corrected for age and weight).

Results: The mean age, was higher in the osteoporosis group (P <0.05), the body mass index was increased in the normal BMD group (P <0.05), but the mean stature was decreased in the osteoporosis group (P <0.05).

The mean glycem ia and HbAc1 levels were similar among those groups. Nevertheless, the mean T and E2 were significantly decreased in the low BMD and osteoporosis groups as compared with the normal bone mass group (P <0.05).

The BMD at the lumbar spine and at the hip were significantly related with E2 blood levels, but not with T blood concentrations.

Conclusions: The results of this study suggest that patients 60 years old or older with DM2 (duration more than 10 years) may have an increased risk for osteoporosis. The low sex steroid hormone plasma levels appear to be significant risk factors for osteoporosis in DM2 males. Finally, these data show also evidence that increased E2 plasma levels may also account for the relative protection of bone loss mechanisms in DM2 men.
Low calcium diet – the risk of carriage disorders and osteopenic syndrome in adolescents

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Aim of study: To evaluate calcium and bone tissue metabolism in adolescents with different quantity of food calcium supply.

Materials: 88 adolescents with carriage disorders aged 14-17 were examined. The control group was consisted of 40 healthy adolescents without bone disorders. Before including the study all patients were examined by orthopedist to characterize their carriage disorders. The exclusion criteria were internal organs diseases that could influence calcium and bone tissue metabolism, endocrine disorders, obesity, low body weight.

Methods: Dietary peculiarities, quantity of calcium supply in all patients were evaluated. According to quantity of food calcium supply 3 variants of diet were distinguished: diet contained less than 800 mg of calcium daily; diet with 800-1000 mg of calcium daily and diet contained more than 1000 mg daily. The levels of calcium, magnesium, phosphorus, alkaline phosphatase, parathyroid hormone, osteocalcini, âCrossLaps were examined. X-ray and dual-energy X-ray absorbiometry were provided.

Results: In group of adolescents with carriage disorders the deficiency of calcium in diet was revealed more frequently. In 70 patients (79%) food calcium intake was less than 800 mg daily, in 10 patients (11%) – 800-1000 mg daily, and only in 9 patients the quantity of calcium in diet exceeded 1000 mg daily. In the majority of adolescents from control group food calcium intake exceeded 1000 mg daily and only in 2 patients (5%) it was less than 800 mg daily. Lower average blood levels of calcium in adolescents with carriage disorders in comparison with those levels in healthy adolescents (alkaline phosphatase 204±18U/l vs 301±12U/l (p<0,01); osteocalcini 82,21±4,82ng/ml vs 116,04±4,22ng/ml (p<0,01); âCrossLaps 1,18±0,3ng/ml vs 1,51±0,4ng/ml (p<0,01). The level of parathyroid hormone was also lower in patients with carriage disorders than in healthy adolescents (p<0,05). X-ray examination showed the delay of bone age from biological one in 80% of patients with carriage disorders and only in 4% of patients in control group. Osteopenic syndrome in adolescents with carriage disorders was revealed more frequently than in patients of control group according to the results of dual-energy X-ray absorbiometry.
Quercetin and grape seed extract affect MC3T3-E1 preosteoblast proliferation and inhibit osteoclastogenesis

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Polyphenols are the most abundant antioxidants in the diet and are widespread constituents of fruit, vegetables, cereals, dry legumes, chocolate and beverages such as tea, coffee or wine. Several of these polyphenols may affect bone formation or resorption.

Objectives: We compared the effect of grape seed extract (GSE) to that of quercetin on osteoblast proliferation, osteoclastogenesis and osteoclast activity. Quercetin reduces osteoclastogenesis, and may induce apoptosis in the mature osteoclast (1,2). The effect of GSE on bone cells in vitro has not been investigated before.

Methods: MC3T3-E1 subclone 4 murine preosteoblasts were treated with quercetin and GSE at 1 ng/ml – 1 mg/ml for 24 hours. Proliferation was assessed using the MTT assay. RAW 264.7 cells were transformed into osteoclasts by exposure to 15 ng/ml RANKL for 5 days in the presence or absence of quercetin or GSE (10 ng/ml – 10 ug/ml). Tartrate resistant acid phosphatase levels in the culture media were assayed on day 5 and osteoclasts visualised. Lactoferrin was used a positive control for both assays. Caspase-3 levels were assayed after exposing newly formed osteoclasts to the extracts (10ug/ml) for 24 hours. A caspase inhibitor, zVAD-fmk served as a control.

Results: GSE did not affect MC3T3-E1 cell proliferation and was cytotoxic above 100 ug/ml. Quercetin significantly increased proliferation at 10 ug/ml. Both GSE and quercetin significantly inhibited osteoclastogenesis at 10 ug/ml. GSE had no effect on caspase-3 levels while quercetin increased caspase-3 levels but not significantly as compared to control.

Conclusion: The results indicate that quercetin affects osteoblast proliferation and confirms that quercetin affects osteoclastogenesis (1). Studies in rats showed that GSE can increase bone formation and reverse calcium deficiency induced bone debility (3,4). Though our results confirm an effect by GSE on osteoclastogenesis, further work is therefore required to establish a mechanism of action of GSE on bone.

The effect of calcium intake on bone growth, bone turnover, bone density and bone strength in young growing rats

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A low Ca intake by adult rats and humans decreases bone mass and increases the risk of osteoporosis. The skeletal effect of Ca intakes is however less clear during periods of bone mineral accrual. Sixty 4-week-old male Sprague-Dawley rats, were randomized according to weight into 6 groups of 10 rats each and fed ad libitum a diet containing normal (1.2%) and low (0.2%) Ca content; Ca/Pi ratio was maintained constant. Rats were sacrificed after 1, 2 or 4 weeks of treatment. Bone dimensions were measured by digital calliper and femur midshaft thickness by micro-tomography. Bone turnover was followed by seric bone markers (CTX-I and Osteocalcin). Bone mineral density (BMD) was quantified by DEXA and femoral strength was evaluated by the 3 point bending test. Differences between normal and low Ca intake groups were evaluated by Man Whitney test. All along the study, food intake and body weight remained unaffected by the dietary restriction of Ca for 4 weeks. The IGF-I level remained unaffected after 2 weeks of treatment but started to decrease after 4 weeks in the low Ca group (p=0.004) compared to the normal calcium group. Femur length, bone volume and cortical thickness increased over time in all groups but these parameters slightly decreased after 4 weeks in the low Ca group (p=0.0002 for all parameters). We also found a higher level of CTX-I and osteocalcin in the low Ca group (p=0.001; p=0.0002 respectively at 4 weeks), which is indicative of an elevated rate of bone turnover. In addition, bone mineral density (BMD) increased over time in all groups but was significantly lower in the low Ca group during week 1 (p=0.002), week 2 (p=0.0002) and week 4 (p=0.0002). Lastly, the decrease of BMD in the low Ca group was associated with a decrease in stiffness (p=0.0002), ultimate strength (p=0.0004) and work to fracture (p=0.004) after 4 weeks. In conclusion, these results suggest that a low dietary Ca intake in young growing male rats had a detrimental effect on bone density and bone turnover which affected bone growth and bone strength.
P55
Counterintuitive relationship between IGF-1 and bone turnover in Irish professional jockeys


Professional jockeys undertake calorie restricted diets in order to meet low-weight targets required for racing. Due to the heavy demands of work related tasks, jockeys have a high energy expenditure and operate in a state of chronic energy deficit. Additionally, horse racing is a high risk sport with a high incidence of falls and injuries reported. These combined factors can have an adverse affect on bone health. The objective of this study was to investigate the relationship between the IGF-1, bone mineral density (BMD) and bone turnover markers (BTM) in a group of professional jockeys.

BMD was measured in 27 male jockeys. 14(52%) of the 27 jockeys had low BMD. A subset of 12 jockeys with BMD T-score at hip or spine at or below -1.0 was investigated further including measurement of BTM and IGF-1. Relationships between IGF-1 and BMD, BTM, the bone turnover indices (the arithmetic mean of a bone formation marker and bone resorption marker) were assessed using the Spearman correlation.

IGF-1 levels were all within the normal range for age. IGF-1 correlated negatively with BMD T score at the hip (r= -0.625; p<0.05) but not the spine (r= -0.4728; p=ns). There was a positive correlation between IGF-1 and bone formation markers procollagen type 1 N propeptide (r=0.810; p<0.002), intact osteocalcin (r= 0.714; p<0.01), and bone alkaline phosphatase (r=0.322; p=ns). In addition there was a positive correlation between IGF-1 and the bone resorption markers N-terminal telopeptide of type I collagen (r=0.760; p<0.005) and deoxypyridinoline crosslinks (r=0.806; p<0.002). When the BTMs were used to calculate a bone turnover index, significant correlations were noted for 5 out of 6 combinations (r values from 0.648 to 0.844; p<0.05). These findings suggest that factors other than nutritional intake contribute to the IGF-1 levels. The riding position jockeys maintain during racing places a greater load on the hip compared with the spine, which may explain the significant correlation between hip BMD and IGF-1. The repetitive nature of horse-riding along with multiple falls, may lead to microdamage or even microfractures in the skeleton that is being continuously repaired by increased bone turnover. IGF-1 may be contributing to this increased turnover state, acting as a mechanosensor, and promoting bone formation and resorption by activating signaling pathways.
P56

Effect of protein intake on volumetric bone parameters in healthy Spanish women


Introduction and objectives: The role of dietary protein intake in bone mass still remains controversial. Increasing dietary protein results in a raise of urinary calcium. Several studies have shown a positive association between protein intake and bone mass. However, other studies observed that protein was negatively associated with bone measurements, or have not found any association. To this light, the aim of this study is to contribute to clarify the effect of protein intake on volumetric bone parameters.

Methods: We evaluated bone status using a peripheral quantitative computed tomography device that measured total, trabecular and cortical bone mineral density in 701 healthy Spanish women (mean age 50.14 ± 9.21 years old). Nutrient intake was assessed using a 7-day-record questionnaire. Mean protein intake was 88.46±26.72 grams per day. The study subjects were taking no medication, and had no disease known to affect mineral metabolism that could interfere with calcium metabolism.

Results: Taking volumetric bone parameters as dependent variables and biological factors (age, age of menarche, years since menopause) anthropometrics factors (weight, height, body mass index) and nutrient intake (calcium, phosphorus, calcium/phosphorus index, proteins, calcium/proteins and proteins per kilogram of body weight) as independent variables, we found that age and calcium/protein index are determinant, negatively, of total density (p<0.0001). Age and calcium/proteins index, negatively, and phosphorous and calcium/phosphorous index, positively, are determinant of cortical density (p<0.04). Moreover, age and calcium/proteins index, negatively, and height, positively, are determinant of trabecular density (p<0.04).

Conclusion: In this group of healthy Spanish women, we found a negative effect of protein intake on volumetric bone parameters measured by peripheral quantitative computed tomography.
P57

Relationship between bone mineral density, lean body mass, vitamin D status and parathyroid hormone in postmenopausal women: a prospective study

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Objectives: To assess the relationship between bone mineral density (BMD) and lean body mass, vitamin D and parathyroid hormone (PTH) in Saudi postmenopausal women. Subjects and Methods: A total of 790 Saudi postmenopausal women living in the Jeddah area were studied. Bone mass and lean body mass were measured by a dual-energy X-ray absorptiometry. Plasma 25-OH-D3 and intact-PTH were measured together with biochemical bone turnover markers including [formation: serum osteocalcin (OC), bone-alkaline phosphatase (BAP); and absorption: C-telopeptide fragment of type 1 collagen (sCTx), and cross-linked N-telopeptide type 1 collagen (sNTx)] and serum calcium, phosphate and magnesium. The relationship between bone mass and lean body mass and other variables were examined using univariate analysis by means of Chi-square test and multivariable analysis using multiple logistic regression. ANOVA was used to examine the differences among women according to quartiles of 25-OH-D3 values.

Results: Serum 25-OH-D3 correlated with all skeletal sites in women studied except for the spine (r = 0.18-0.32; P<0.05) BMD at sites enriched in cortical bone were 0.3-0.8 SD lower in the women with the lowest vitamin D quartile as compared with that in the highest quartile. After adjusting for intact-PTH, the magnitude of correlation between BMD and 25-OH-D3 remained significant. After controlling for lean body mass the magnitude of these correlations did not significantly change. After controlling for age and height, both lean body mass and intact-PTH contributed significantly to BMD variation at all skeletal sites examined. Adjusting for age, height, lean mass, PTH, 25-OH-D3 did not show any significant residual contribution to BMD variation.

Conclusion: Vitamin D effects on BMD in postmenopausal women is largely mediated via variations of intact-PTH rather than that of lean body mass.
Objectives: To determine the factors influencing vitamin-D status in relation to serum 25(OH)D3, bone turnover markers (BTMs), bone mineral density (BMD) and vitamin-D receptor genotype (VDR) in Saudi women. Subjects and Methods: A total number of 1267 healthy Saudi women [age =31.9 ( 7.56 ) yrs and 66.61 ( 10.8 ) yrs] were pre (n=755) and postmenopausal (n=512), respectively] living in the Jeddah area were randomly selected and studied. Anthropometric parameters, socioeconomic status, sun exposure index together with serum concentrations of calcidiol (25-OHD3), calcitriol (1,25(OH)2D3), intact-PTH, Ca, PO4, Mg, creatinine, albumin and biochemical BTMs were measured. BMD was measured by a dual energy X-ray absorptiometry and VDR genotypes were also determined. The relationship between vitamin-D status and other variables were examined using univariate analysis by means of Chi-square test and multivariate analysis using multiple logistic regression analysis. ANOVA was used to examine the differences among women studied according to vitamin-D status. Results: About 54.5% of Saudi women studied exhibited vitamin-D deficiency (45.8% and 67.0% in pre- and postmenopausal women with serum 25-OH3 values <50 nmol/L respectively. About 78.8% of Saudi women studied exhibited vitamin-D insufficiency with serum 25-OHD3 values <75 nmol/L. No significant differences in 25-OH3 levels were evident among Saudi women wearing different dress style. Serum 25-OH3 levels correlated positively with age (r=0.31), parity (r=0.22), dietary vitamin-D intake (r=0.18), sun exposure index (r=0.22), serum Ca (r=0.15), phosphate (r=0.16), and inversely related to intact–PTH (r=0.29), OC (r=0.17), BAP (r=0.15), sCTX (r=-0.20) and sNTX (r=-0.21) (at P<0.05 for all correlations), respectively. Multiple linear regression analysis showed that age, dietary vitamin-D intake, socioeconomic status, and sun exposure index were independent positive predictors of serum 25-OH3 values (R2=0.22). The frequencies of VDR genotypes were 32% GG, 45.2% AG and 22.8% AA respectively. There was no significant contribution of VDR genotypes to BMD or BTMs. Conclusions: Vitamin-D deficiency is highly prevalent among healthy Saudi pre- and postmenopausal women and largely attributed to insufficient sunlight exposure and poor socioeconomic status. It is also associated with increased bone turnover with no influence of VDR genotypes on BMD or BTMs.
Objective: To evaluate vitamin D status in Saudi men with osteoporosis in relation to changes in biologically active “free” vitamin D due to variation in plasma vitamin D binding protein (DBP).

Design: Prospective cohort study.

Subjects and Methods: A total of 85 Saudi men with idiopathic osteoporosis [mean (SD) age, 58.2 (14.5) years; range 24-75] were studied in comparison with 170 age-matched healthy Saudi men without osteoporosis [mean (SD) age, -57.9 (13.3) years; range 24-71] who were living in the Jeddah area. Anthropometric parameters together with plasma concentrations of calcidiol (25-OHD3), calcitriol (1,25(OH)2 D3), DBP, intact-PTH, Ca, PO4 and mg were determined in all studied men. Bone mineral density (BMD) of the spine (L1-L4) and neck femur were determined using DXA technique and men were classified with osteoporosis according to WHO criteria. Mann-Whitney testing was used to determine significant differences among men with and without osteoporosis.

Results: Men with osteoporosis exhibited markedly lower BMD values at various skeletal sites examined as compared with that of the corresponding controls. Men with osteoporosis exhibited significant increases in plasma DBP [188.9 (52.1) mg/L] than in the controls [122.5 (38.4) mg/L] (P<0.001), respectively. No significant differences were evident in the plasma levels of 25-OHD3 and 1,25(OH)2 D3 among men studied. Calculated free plasma 25-OHD3 and levels of 25-OHD3 and 1,25(OH)2D3 were significantly increased in men with osteoporosis than in corresponding controls [5.1(3.04) vs 8.pmol/L] (P<0.001) and [60.8 (34.6) vs 130.6 (56.8) fmol/L] (P<0.001), respectively.

Conclusions: Measurement of total vitamin D metabolites alone, although provide a crude evaluation of vitamin D status, may not be an accurate estimate of the free “biologically active” form of the vitamin. The ratio of total 25-OHD3 and 1,25(OH)2D3 to plasma DBP may be more useful indication of biological activity.
Effectiveness of potassium bicarbonate administration to prevent sodium chloride-induced bone loss

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It is well known that a high sodium chloride intake affects calcium metabolism and may therefore be related to the risk of osteoporosis. We have recently shown that high sodium chloride intake led to a low-grade metabolic acidosis accompanied by an increase in bone resorption (Frings-Meuthen et al. J Bone Miner Res, 2008). Since pH decrease is a mandatory condition to activate osteoclasts, we hypothesize that the increased bone resorption is initiated by a low-grade metabolic acidosis. Administration of an alkali salt may counteract the acidosis and thereby decrease so chloride-induced bone resorption.

In a strictly controlled metabolic ward study with 8 healthy male test subjects (mean age: 25.8 ± 3.9 years; body weight (BW) 75.4 ± 3.6 kg) we examined the ability of potassium bicarbonate (KHCO3) to prevent sodium chloride-induced bone loss. 4 days of adaptation with a normal sodium chloride intake (2.8 mEq/kgBW/d) were followed by 10 days of a high sodium chloride intake (7.7 mEq/kgBW/d) combined in one trial with the supplementation of 3 x 30 mmol KHCO3 per day in a cross-over design. Urinary calcium (UCa) and bone resorption markers (C- and N-terminal telopeptide of type I collagen (CTX, NTX)) were analyzed in 24 hour urine. Fasting morning blood was analyzed for the bone formation markers, bone specific alkaline phosphatase (bAP), and N-terminal of propeptide of type I procollagen (PINP). Postprandial parathyroid hormone (ppPTH) measurements were used to provide an insight into the involvement of PTH in sodium chloride-induced bone loss. KHCO3 supplementation was able to reduce sodium chloride-induced calciuria by only 12 % (p = 0.04) and NTX excretion by only 8 % (p = 0.04); no significant decrease was observed in the bone resorption marker CTX (p = 0.18). Bone formation marker PINP (p = 0.92) and bAP (p = 0.95) remained unchanged. However, ppPTH levels were twofold higher after KHCO3 administration (p < 0.001). High sodium chloride intake itself did not affect ppPTH. KHCO3 was not able to prevent sodium chloride-induced increased bone resorption maybe due to so far unknown interactions with PTH.
Hospitalization in a department of internal medicine, a window of opportunity for vitamin D replenishment

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Introduction: Vitamin D deficiency is common in the elderly in Israel. Awareness of this condition and adherence to vitamin D supplementation is low. It has been recently demonstrated that administration of a single dose of 100 000 IU of vitamin D3 can effectively correct vitamin D status without toxicity. The aims of this study were: to assess vitamin D status in patients (pts) hospitalized in the Departments of Internal Medicine in Rambam Health Care Campus and to detect factors connected to vitamin D deficiency, to compare the efficacy of vitamin D supplementation initiated during hospitalization to the currently practiced treatment in the community.

Patients and Methods: During hospitalization and at the end of the study data was collected about pts’ health status, sun exposure, medications, nutritional habits, functional status, falls and routine laboratory evaluation. 25(OH)D and PTH were assessed at inclusion and after 2 months (mths). Pts were randomly assigned to oral vitamin D3 (D3 solution CTS, Israel) supplementation of 100 000 IU/ monthly for 2 mths (group I, the second dose was administered during an outpatient clinic visit or at pts’ home under study physician’s supervision), or treatment in the community, following an information letter about pt’s vitamin D status (group II).

Results: 150 pts aged 76.2 +/- 12.8 (range 65-89), 85 women and 65 men were included in the study. 25(OH)D serum level was 16.2 +/- 17.8 ng/ml. Vitamin D deficiency correlated with age (p=0.03), female gender (p= 0.018), falls and functional capacity. 107 (71.3%) patients completed the study. At the end of the study 25(OH)D serum level (ng/ml) >32 was observed in 25(50.9%) vs. 4 (7.7%), 25(OH)D serum level 20 – 32 in 26(49.1%) vs. 23(44.2%), 25(OH)D serum level <10 in none versus 5 (9.6%) in group I and II respectively. The likelihood of achieving 25(OH)D serum level > 32 ng/ml in patients with initial serum level <10 ng/ml was 40% vs. 0%, with 10-20 ng/ml 30.4% vs. 0%, with 20-32 ng/ml 79% vs. 18.2% in group I and II respectively. Musculoskeletal complaints and falls decreased in group I vs. II (p=0.001;0.014)

Conclusions: Vitamin D deficiency is common in pts, especially in women and aged, hospitalized in the Departments of Internal Medicine. Treatment with a monthly dose of 100 000 IU of vitamin D3 for 2 mths, initiated during hospitalization, is superior to the treatment administered in the community, although it has not ensured vitamin D adequacy in all patients.
Introduction: Vitamin D deficiency is common in the population of mentally disabled. Unfortunately, it mostly remains untreated. The objectives of this study were: assessment of vitamin D and PTH status in residents of a rural institution for developmentally disabled; evaluation of two therapeutic strategies aimed to normalize vitamin D status.

Patients and Methods: Stage I: Assessment of vitamin D and PTH status. Stage II: An open randomized, 3 months (July-September) interventional trial, comparing between monthly supplementation with 50,000 IU vitamin D3, supervised sun exposure, 15 minutes per day at midday, 25% of body area and a control group.

Results: Stage I – 153 residents – 86 men and 67 women – aged 37.6 ± 12.1, were included. Serum 25(OH)D (ng/ml) was 10.7 ± 6, 25(OH)D < 20 was observed in 92.2%. Plasma PTH concentration was 34.22 ± 17.95 pg/ml, (normal 11 – 62). Multiple regression analysis revealed a significant negative correlation between Carbamazepine use (p < 0.001, n=32), Prothiazin (p=0.02, n=18), behavioral disturbances (p=0.031, n=27) and serum 25(OH)D concentration. These 3 variables explain 17.7% of the decrease in 25(OH)D concentration. No significant correlation was established with any other parameter. Stage II – At the end of the study 25(OH)D significantly increased (p < 0.0001) by 16.02 +/- 6.3 ng/ml to 26.83 ± 5.6 ng/ml, by 15.53 +/- 7.4 ng/ml to 25.52 +/- 5.7 ng/ml, and by 8.23 +/- 6 ng/ml to 18.16 +/- 8.5ng/ml, in groups I, II, and III respectively. Both types of therapeutic intervention contributed to a significant rise in serum 25(OH)D concentration compared to a control group (p < 0.0001), with no significant difference between the treatment groups (p < 0.397). The implementation of the sun exposure treatment was more complex. From the assessment of oral supplement treatment – an intake of 104 IU of the vitamin corrected serum 25(OH)D concentration by 1 ng/ml. After controlling for seasonal (summer) vitamin D production (the control group), 214 IU of the vitamin were needed in order to induce 25(OH)D serum concentration increase by 1 ng/ml.

Conclusions: Vitamin D deficiency was common, partly due to medication use. Both types of treatment improved vitamin D status, but were unable to achieve optimal levels of > 30 ng/ml. The treatment with sun exposure was more complex and difficult to implement, in comparison with the oral supplement given once a month. Higher supplement doses may be needed for achievement of vitamin D adequacy.
P63
The effect of 1000 IU of vitamin D2 on increasing 25OHD concentration decreases as baseline 25OHD concentration increases
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Objective: We have shown recently that vitamin D2 1000 IU and calcium reduces falls even in a high sunlight region from 63% per year to 53% per year (1). The aim of this report is to examine the effects of baseline vitamin D status on the 25OHD response in the patients in the study.

Methods: 302 women aged 70 years and above with serum 25OHD concentrations less than 60 nmol/L participated a 1 year randomised, double-blind, placebo controlled trial. The subjects were recruited from a random sample of 3,698 women from the general population. During the study, subjects received 1000 mg calcium citrate per day with 1000 IU ergocalciferol (vitamin D) or identical placebo (control). One year results were available in 261 women. Serum 25OHD was measured at baseline and one year using the Diasorin RIA assay.

Results: At baseline 25OHD varied from 19 to 60 nmol/L (mean 44.6 (SD 12.9) nmol/L) in both groups. At one year 25OHD increased to 59.8 (SD 13.8) nmol/L in the vitamin D group but remained constant in the control group. In the vitamin D group, greater improvements in 25OHD was observed in those with baseline concentrations below 45 nmol/L compared with those above (changes from baseline: 24.0 (SE 1.7), 7.1 (SE 1.7) nmol/L, respectively, P < 0.001) despite the same supplement size. Whereas in the placebo group, the difference in the change in 25OHD levels over the 12 months between those with baseline 25OHD below and above 45 nmol/L was much smaller (changes from baseline: 3.0 (SE 0.9), -1.1 (SE 1.4) nmol/L, respectively, P = 0.02). For those with baseline 25OHD of 55 nmol/L or greater there was no significant increase in 25OHD in the vitamin D group and there was a significant reduction of 5.5 nmol/L in the placebo group (P = 0.022).

Conclusions: Vitamin D therapy of 1000 IU per day was less effective in increasing 25OHD in those with higher baseline 25OHD. 25 hydroxylation of vitamin D substrate demonstrates some feed back regulation.

North versus south differences in sunlight exposure and seasonal vitamin D status of UK postmenopausal women: results from a longitudinal study

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The UK has insufficient intensity of sunlight at the appropriate wavelength (290-315 nm) to enable cutaneous synthesis of vitamin D from October-April. There are regional differences in sunlight quality/UVB strength but whether this translates to differences in vitamin D status is not known. We have reported seasonal variations in a cross-sectional study of over 3000 Scottish women in Aberdeen (Macdonald et al 2008). In this longitudinal study we compared the seasonal variation of serum 25-hydroxyvitamin D [25(OH)D] in postmenopausal women residing in the North (Aberdeen, 57°N) and South (Surrey, 51°N) of the UK. Postmenopausal women attended 3-monthly visits over 12 months, starting summer 2006. In Aberdeen, 338 Caucasian women (mean age ± SD, 61.7 ±1.5 y); and at Surrey, 138 Caucasian women (61.4 ± 4.5 y) and 35 Asian women (59.9 ± 6.4 y) had serum 25(OH)D measured by IDS enzyme immunoassay. Women wore badges of polysulphone film (for a total of one week, each season) to assess sunlight exposure. One standard erythemal dose (SED) is equivalent to an erythemal effective radiant exposure of 100 J m-2.

The median SED estimated for the year was 145 for Aberdeen. For Surrey the median SED was 152 for Caucasian women and 60 for Asian women. These data do not take into account how much of the body is exposed to sunlight. In winter/spring over 20% of subjects in Aberdeen had 25(OH)D < 25 nmol/L whereas the figure was 10% of Caucasian women living in Surrey. This number decreased in summer/autumn. Fifty percent of Asian women residing in the Surrey were vitamin D-deficient in summer, increasing to 76% in spring. Using higher 25(OH)D sufficiency cut-offs, the percentage of women affected was much higher. Between 80-95% Caucasian women in Surrey; over 90% women in Aberdeen; and almost all Asian women in Surrey had 25OHD< 75 nmol/L.

These longitudinal data show clear differences in vitamin D status between the North and South of the UK, and marked ethnic differences. They are consistent with our previous data and with cross-sectional data from the 1958 birth cohort (Hypponen & Powers 2007). The low vitamin D status may have implications for bone health and other health outcomes, which is currently being investigated in this publication group. The extent of vitamin D deficiency in Asian women residing in the South of England is of concern.

Macdonald et al Bone 2008; 42:996-1003
Low calcium-to-phosphorus ratio in habitual diets interfere with calcium and bone metabolism in healthy pre-menopausal women with in a generally adequate calcium intake

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Objectives: Excessive dietary phosphorus (P) intake alone can be deleterious to bone through increased parathyroid hormone (PTH) secretion, but adverse effects on bone increases when dietary calcium (Ca) intake is low. In many countries the P intake is abundant whereas the Ca intake does not meet recommendations, therefore, optimal dietary calcium-to-phosphorus ratio (Ca:P ratio) is difficult to achieve. Our objective was to investigate the impact of Ca:P ratios of habitual diets on Ca and bone metabolism markers in a population with in general adequate dietary Ca intake.

Methods: In this cross-sectional analysis of 147 healthy Finnish women aged 31-43 y fasting blood samples and 24-h urinary samples were collected. Participants kept a 4-d food record, and were divided into quartiles according to their dietary Ca:P ratios.

Results: The 1st quartile with Ca:P molar ratio <=0.50 differed significantly from the 2nd (Ca:P molar ratio 0.51-0.57), 3rd (Ca:P molar ratio 0.58-0.64), and 4th (Ca:P molar ratio >=0.65) quartile by having deleterious impact on Ca and bone metabolism. Compared to all the other quartiles, the mean serum PTH (S-PTH) concentration (P=0.021) and the mean urinary Ca (U-Ca) excretion were higher (P=0.050), and the mean urinary P excretion (U-Pi) was slightly increased (P=0.13) in the 1st quartile. Among all the participants the mean dietary Ca intake was 1056 mg/d (SEM 34), the mean dietary P intake was 1411 mg/d (SEM 33) and the mean Ca:P molar ratio was 0.57 (SEM 0.01).

Conclusions: In the present study even when participants had in general adequate or high dietary Ca intake a suggested Ca:P ratio of 1 was impossible to achieve. These findings suggested that in habitual diets of healthy pre-menopausal women low Ca:P ratios may interfere with usual homeostasis of Ca metabolism and increase bone resorption as indicated by higher S-PTH, and U-Ca levels together. In Western diets low Ca:P ratios are common and it seems difficult to decrease P intake on the recommended level, thus, more attention should be focused on decreasing excessively high P intake and increasing Ca intake to meet dietary guidelines.
Is salt sensitivity the link between hypertension and osteoporosis?

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The question whether increased sodium chloride (NaCl) intake increases osteoporosis risk remains unresolved; some studies suggest so, others not. Increased NaCl intake can increase blood pressure, with greater increases in salt-sensitive (SS) subjects than in salt-resistant subjects (SR).

In 37 normotensive African-American (AA) subjects, mean age 46±3 yrs (30 M; 7 F) we recently tested the hypothesis that SS subjects have an impaired vasodilatory response to NaCl loading mediated by increased levels of asymmetric dimethylarginine (ADMA), which suppresses nitric oxide (NO) synthesis. 19 SS and 18 SR subjects were admitted to the UCSF Clinical Research Center and followed daily for one week on standardized 30 mmol NaCl diets, then changed to 250 mmol NaCl daily. The SS group had a 40% increase in ADMA levels (p<0.007) associated with a 15% higher mean arterial blood pressure (p<0.01) compared to the SR group.

Recently, some small clinical trials using NO sources (e.g., isosorbide dinitrate) in post- or surgically-induced menopausal women have shown improvement in bone mineral density (BMD) comparable to alendronate or estrogen replacement therapy. This may be due to NO-induced activation of osteoblasts and inhibition of osteoclasts. We hypothesize that SS subjects on high salt diets should therefore be less likely to respond to NO treatment for osteoporosis than SR subjects and more likely to have low BMD.

Consistent with this theory, Galletti et al (J HTN 1993;11:S194) have shown that urinary calcium excretion (UCaV) is increased +0.9±0.4 mmol/24 hrs in SS subjects after IV NaCl infusion compared with SR subjects -0.4±0.3 mmol/24 hr (p<0.01). Retrospective analysis of our data demonstrated no difference in UCaV (corrected for creatinine excretion; UCa/CrV) or ADMA levels between our SS and SR subjects on the low NaCl diet. There was no relationship between UCa/CrV and ADMA levels after one week in the SR subjects on the high NaCl diet but a trend towards increased UCa/CrV in the SS subjects (p=0.06). Younger AA subjects are more likely to have higher BMDs than other racial groups; it may be that SS, NO-resistant subjects in other racial groups would have even greater losses of calcium on a high NaCl diet, leading towards greater chances of developing osteoporosis.
Effect of a low carbohydrate weight-reducing diet versus a high fruit and vegetable weight loss diet and a weight control group on markers of bone turnover

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Introduction: The effect of high acidity, weight-reducing diets on markers of bone health remains undefined. The health-related benefits of a high consumption of fruit & vegetables on a variety of diseases, including skeletal health have been advocated by several health organizations. The aims of this study were two fold: (1) determine estimates of net endogenous acid production (NEAP) (measured using the algorithms Pro:K and NAE indirect respectively, as detailed elsewhere Frassetto et al., 2007) in three intervention groups; (i) a low carbohydrate weight reducing diet (LCD); (ii) a high fruit and vegetable weight loss group (F&V); (iii) a weight control group (WM) and (2) investigate the short-term (6mths) effect of the aforementioned groups on bone turnover markers.

Methods: A total of sixty-eight overweight/obese (BMI 27–40 kg/m2) men aged 21–65 years were recruited from the County of Surrey, Southern UK. Subjects initially consumed their usual non-weight-reducing diet for 1 week and were then invited to participate on either the LCD (carbohydrate-restricted induction diet of 20g/d or less for the initial 2 weeks of the diet, increasing slightly thereafter) or an alternative F&V weight-reducing diet (~9 portions of fruit and vegetables/d) for 6mths. A WM control group was also recruited to reflect dietary acidity estimates, indicative of a normal Western diet. Dietary intake, anthropometrics and fasting blood and urine samples were measured at baseline, 2mths and 6mths. Serum N-terminal propeptide of type 1 collagen (P1NP) and serum beta C-terminal telopeptide (CTX) were measured using an ECLIA. Free deoxypyridinoline and pyridinoline cross-links (fDPD and fPYD) were measured using automated techniques. Values were then expressed relative to creatinine (fDPD/Cr and fPYD/Cr, respectively).

Results: Subjects from the LCD group had significantly higher levels of dietary acidity when compared to the F&V or WM groups (p<0.05). There was a significant decrease in estimated NEAP in the F&V group at 6 mths (p<0.05). Repeated-measures ANOVA showed no differences between groups for any of the bone turnover markers measured.

Conclusions: These findings indicate that the acid generating potential of the LCD diet is high, reflective of the high-protein/low potassium contents of the diet. This study did not demonstrate a detrimental effect of high acidic-weight reducing diets on bone turnover markers.

Effects of milk basic protein on RANKL+ T cell-mediated bone metabolism in food-sensitive enteropathy

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Purpose: Bone loss is a common feature in enteropathies such as Celiac disease (CD) caused by gluten intake. Recent studies on enteropathies suggest that the receptor activator of NF-kappa B ligand (RANKL), which acts as a factor of osteoclast formation, may be responsible for bone loss. However, little is known about the pathogenic mechanisms of bone loss in such enteropathies. In this study, we analyzed that the relationship between bone metabolism and RANKL level in food-sensitive enteropathy. We also examined the effect of the basic protein fraction from milk whey (milk basic protein, MBP), which has been shown to be beneficial for bone health, using this model.

Methods: Food-sensitive enteropathy was developed by feeding with ovalbumin (OVA) containing diet in transgenic mice expressing a T cell receptor that recognizes OVA (TCR-Tg). Both TCR-Tg and control BALB/ca mice, were fed with OVA diet for 28 days, and then the femoral bone mineral density (BMD) was measured. At the same time, CD69 and RANKL expressed on CD4+ T cells in the mesenteric lymph node (MLN) and the bone marrow (BM) were analyzed by flow cytometry. In addition the expression of RANKL on CD4+ T cells isolated from TCR-Tg was examined after antigenic stimulation in vitro. Next, RANKL+CD4+ T cells were also isolated from MLN of TCR-Tg and then adoptively transferred into immunodeficient SCID mice by tail vein, and the number of transferred CD4+ T cells in BM was examined. Furthermore, TCR-Tg were fed with MBP-containing OVA diet and alterations in BMD and RANKL expressions were then analyzed.

Results: It was observed that mice with food-sensitive enteropathy showed decreased BMD and increased RANKL+CD4+ T cells in both MLN and BM. The expression of RANKL on CD4+ T cells from TCR-Tg were induced by antigenic stimulation. Moreover, the transferred antigen-stimulated RANKL+CD4+ T cells migrated into BM in SCID mice. It was shown that co-administration of MBP with OVA did not influence on the frequency of RANKL+CD4+ T cells in both MLN and BM, but prevented the decrease of BMD in food-sensitive enteropathy mice.

Conclusions: It was found that oral food antigen induced RANKL+CD4+ T cells in MLN which may contribute to bone loss in food-sensitive enteropathy. Oral co-administration of MBP appeared to be effective in preventing the food antigen-induced bone loss without affecting RANKL expression.
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Vitamin D concentration is associated with muscle mass in men

R. Kallikorm, M. Kull, M. Lember (Tartu, EST)

Background: The importance of muscle mass in relation to age-related decline in physical function is well-known [1]. Vitamin D is reported to contribute to muscle strength [2]. Role of vitamin D on muscle mass has been demonstrated in elderly men [3].

Objectives: To evaluate the role of vitamin D among other possible predictors of muscle mass in an adult population sample.

Methods: A random sample (n = 560) of the Estonian population aged 25-70 years was drawn. The participation rate was 55% (N=308: 134 males and 174 females; mean age 49.3±12.3 years). Appendicular lean mass (ALM) as a measure of muscle mass and body fat (%) were measured with dual-energy X-ray absorptiometry (GE Lunar DPX-IQ, USA). In addition to age and body fat, the following possible predictors of muscle mass were recorded: grip strength (in kg); serum 25(OH)-vitamin D (RIA, DiaSorin, USA); physical activity using the physical activity questionnaire (IPAQ; recorded in MET-minutes/week); average daily milk consumption and sun exposure (semi-quantitatively).

In statistical analysis the Pearson and Spearman correlation testing and multiple linear regression modelling with best-fit selection (ALM as the dependent and grip strength, 25(OH) vitamin D, the IPAQ score, total body fat percent, age, sun-exposure and milk consumption as the independent variables) were used.

Results: Serum level of 25(OH) vitamin D correlated with ALM (p=.03) in men only. This correlation remained significant if adjusted for other determinants in multiple regression analysis. In regression analysis with best-fit variable selection the final model explaining ALM included grip strength (p<.0001), age (p=.002), 25(OH) vitamin D (p=.05), milk consumption (p=.1) and the IPAQ score (p=.14) in men. In women only grip strength (p<.0001) and total body fat percent (p=.02) were significant predictors. These models explained 34% and 18% of the variability of ALM in men and women, respectively.

Conclusion: Vitamin D seems to be an independent predictor of muscle mass in men only. Grip strength is a strong predictor of total body muscle mass for both genders in this population sample of adults.

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Preliminary analysis of the effects of a fruit and vegetable intervention trial on net endogenous acid production and skeletal health: results from the US Women’s Healthy Eating and Living (WHEL) study

M. Abbate, Y. Jeanes, S. Lanham-New, L. Frassetto
(London, Guildford, UK; San Francisco, USA)

Available evidence implies a role for bone mineral as a reservoir of buffer in the maintenance of acid-base balance during low-grade chronic metabolic acidosis, leading to an increased risk of osteoporosis. Increased consumption of fruit and vegetable as part of an alkalizing diet could influence bone health through the reduction of net endogenous acid production (NEAP). This preliminary analysis uses data collected for the WHEL Study and it is aimed at comparing dietary nutrients intake and NEAP between the intervention arm (WHEL, n79), consuming 8-9 portions of fruit and veg daily, and the matched control arm (NCI (National Cancer Institute), n93), consuming 3-5 portions as well as studying the relationship between dietary protein, K, Mg, Ca, Na and NEAP with markers of bone health. Dietary data were collected via FFQ at baseline, 12 and 48 months for 179 women. Plasma alpha- and beta-carotene concentrations were also measured. BMD, BMC and bone area of the femur at different sites were taken for 105 women using DXA technology at various times over a 10 year period. There were no differences in dietary composition between groups at baseline. Carotenoids concentrations were significantly higher in the WHEL group than in the NCI group at 12 months (P<0.005) and 48 months (P<0.005). The WHEL diet compared with the NCI provided higher Mg (mg/d) at both 12 months [372 (SD 94.1) and 329 (SD 88.2) respectively; P=0.004] and 48 months [352 (SD 97.8) and 301 (SD 85.9) respectively; P=0.001] and K (mg/d) at 48 months [3663 (SD 1055) and 2889 (SD 837) respectively; P=0.001]. NEAP (mEq/d) was greatly decreased for the WHEL group compared with the NCI group at 12 months [–2166 (SD 524) and –1695 (SD 459) respectively;P=0.001] and 48 months [–2004 (SD 596) and –1561 (SD 467) respectively; P=0.001]. Analyses using all subjects showed a positive correlation between protein intakes and trochanter BMD (P=0.017) and BMC (P=0.017), Mg intake and trochanter BMC (P=0.04) and Ca intakes and total femur bone area (P=0.046). BMD, BMC and area of femur at different sites were also found to increase across quartiles of proteins and Mg, and decrease across quartiles of NEAP. Increasing dietary K intake by consuming 8/9 daily portions of fruit & veg decreases NEAP compared with eating 3/5 servings. Moreover we demonstrate a positive effect of these nutrients on indices of bone health. Further analysis of the fruit & veg intervention on bone loss over the study period is currently underway.
Altered antioxidant status in adolescent female gymnasts compared to age-matched sedentary controls: impact on indices of bone health

E. Alshammari, J. Nurmi-Lawton, S. Shafi, A. Taylor, G. Ferns, S. Lanham-New (Guildford, UK)

We have previously demonstrated consistently higher bone mass accumulation in physically active adolescent females compared to age-matched controls in a longitudinal study (1). We have recently shown differences in several markers of antioxidant status; glutathione peroxidase (GPx), superoxide dismutase (SOD) and serum trace elements (Se, Cu, and Zn) (2). The aim of this present study was to examine the association between these markers and indices of bone health in this group.

Thirty eight competitive gymnasts and 40 healthy sedentary adolescent females, aged 8-17 years were investigated. Measurements taken at baseline included: serum GPx, SOD, Se, Zn, Cu and Mg. Total body bone mineral content (TBBMC), bone mineral density (TBBMD) and lumbar spine BMC/bone area (L2-L4BMD/L2-L4BA) were assessed by DXA (Lunar DPX). Bone mass of the right and left calcaneus was measured by Broadband Ultrasound Attenuation (BUA, Cuba Clinical). Dietary intake of trace elements was assessed using 7-day estimated food records.

For the gymnasts, serum Zn was positively correlated with L2-L4 BMC (r =0.308, p<0.03) and L2-L4BA (r =0.328, p<0.032), and TBBMC (r =0.305, p<0.034) as well as BUA of the right (r =0.411, p<0.006) and left foot (r =0.476, p<0.001). Similarly serum Mg was positively related to the BUA (r =0.326, p<0.03) of the left calcaneus. No significant associations were found for the control group, nor were there any significant associations between any other markers and indices of bone health in either group.

Hence, while young female gymnasts have an altered antioxidant profile compared to their less physically active peers, there was no significant association with markers of bone health. However there was a significant positive association between levels of serum Zn and indices of bone mass in this physically active group. Further analysis of bone metabolism markers and longitudinal changes in bone mass are underway to examine the full impact of trace elements on attainment of peak bone mass.

This work was funded by the Ministry of Health in the Kingdom of Saudi Arabia. The National Osteoporoses Society (NOS) funded the gymnast study.

Extensive vitamin D deficiency among Kuwaiti adolescent females during the summer period: effects of lifestyle habits and implications for PBM attainment

(Kuwait, KWT; Guildford, Manchester, UK)

Extremely high temperatures in the summer months of Kuwait is common, thus, encouraging the population to avoid the heat and limit their sun exposure. Given that (1) UVB exposure is the main source for vitamin D production; (2) veiling is common in the region, the Kuwaiti female population might be at risk of vitamin D deficiency. Few data are available in adolescent females, which are a group of very special interest given that maximum bone mineral accrual during adolescence, is crucial for high peak bone mass (PBM) attainment. Therefore, the aim of this study was to assess the extent of vitamin D deficiency/insufficiency among adolescent females in Kuwait during the summer and to assess the impact of lifestyle factors on vitamin D status as well as PBM attainment.

A total of 123 adolescent females (mean age 14.98 ± 1.8 y) were recruited from different schools between the months of June and August 2005/2006. Fasting blood samples were collected for assessment of vitamin D status. 25-hydroxyvitamin D was analyzed by HPLC in a validated laboratory in the UK. Bone mineral content and bone mineral density-z-score (BMC & BMD-z-score) of the lumbar spine (L1-L4) were measured using DXA (Hologic, QDR4500, USA). Anthropometric measurements and assessments of skin colour, sun exposure, physical activity levels and dietary intakes (using a FFQ) were determined in all females.

Results of vitamin D status indicated that 75.6% of the females had 25OHD levels below 25 nmol/L (mean: 22.6 ± 8.44 nmol/L, range: 10.5 - 61.0 nmol/L). A total of 67.4% of the females reported up to 5 min of daily sun exposure, whereas only 13% of the girls claimed they were daily exposed to =>30 min. No differences in their 25OHD levels were detected. However, those who were veiled had generally lower levels than those who were unveiled (p<0.05). Also, those who consumed =>3 cups of milk weekly had significantly higher 25OHD levels compared to those who consumed =<1 cup of milk weekly (p<0.05). Milk consumption and veiling (veiled vs. unveiled females) were found to be significant predictors of their vitamin D status (Adjusted r2= 0.091, p<0.05). These results suggest extensive vitamin D deficiency amongst the Kuwaiti adolescent females in the summer, with an impact of key lifestyle factors. Further analysis of the data is underway to determine the influence on PBM attainment.
Extensive vitamin D deficiency/insufficiency in Saudi Arabian adolescent males and females: implications for peak bone mass attainment

M. Al-Ghamdi, S. Lanham-New, J. Khan (Jeddah, SA; Guildford, UK)

There are few data available concerning the vitamin D status, lifestyle characteristics and bone health of adolescent males and females living in Middle Eastern countries generally, but particularly in the Kingdom of Saudi Arabia. These data are urgently required in order to develop public health strategies for preventing future osteoporotic fracture. The aim of this study therefore was to determine the extent of poor vitamin D status in schoolchildren and examine specifically if there was any difference in status with chronological age. This study forms part of an on-going research programme on vitamin D and bone health at the King Abdul Aziz University (KAAU) in Jeddah (Khoja et al 2007).

A total of 150 boys (age range 7-16 years) and 150 girls (age range 6-18 years) of school age participated in this study. Subjects were recruited from a selection of schools in the region and invited by letter to partake in the study. A fasted blood sample was collected for assessment of 25OHD, Ca, albumin and PTH, together with a lifestyle questionnaire. Bone mineral density (BMD) was determined at the lumbar spine (L2-L4) using DXA (Lunar Corp., DPX version 4.7). Calcaneal bone mass was measured by BUA (CUBA plus+ softwareV4). All subjects were interviewed concerning their habitual dietary intake, physical activity levels and general lifestyle. Measurements were also made on weight and height.

The mean age in the boys and the girls was 11.2 yrs [SD 2.4] vs. 11.3 yrs [SD 2.4] respectively. Vitamin D status was significantly higher in the boys (25HOD =54.9 nmol/l [SD 13.7]) than the girls (25HOD =32.7 nmol/l [SD 10.7]), with a concomitant higher PTH for the girls (7.7pmol/l [SD 5.6]) vs. the boys (5.5 pmol/l [SD 3.2]). When groups were examined by age, given that veiling in Saudi Arabian girls commences at puberty (mean age ~ 12 yrs), 25OHD was significantly lower in the older girls (>12 yrs, n=82) (28.1 nmol/l [9.9] than their younger (n=68) counterparts (38.3 nmol/l [9.0] (p<0.001) with a parallel increase in PTH in the older group (9.3 pmol/l [6.7] vs. 5.9 pmol/l [5.1]. These results are a cause for concern. Further analysis is underway to examine the effects of poor vitamin D status on PBM attainment.


Financial support from the King Abdul Aziz University (KAAU) is gratefully acknowledged.
A meta-analysis to quantify the contribution of dietary phosphate to the progression of osteoporosis under the acid-ash diet hypothesis


The acid-ash hypothesis posits that the excretion of “acidic” ions derived from the diet, such as phosphate (PO4), contribute to calciuria, demineralization of bone, and osteoporosis.

The objectives of this meta-analysis were to quantify the contribution of PO4 to bone loss in healthy adult subjects; specifically, to assess the effect of PO4 on a) urine calcium and calcium balance, and to assess whether these affects are altered by the b) level of calcium intake, and c) the degree of protonation of the PO4 supplements.

Methods: Literature was identified through computerized searches regarding PO4 with surrogate and/or direct markers of osteoporosis. Studies were assessed for methodological quality.

Results: 12 studies including 32 interventions manipulated subjects’ PO4 intakes. None of the studies examined changes in bone mineral density or incidence of fractures. All of the meta-analyses demonstrated significant decreases in calciuria in response to the PO4. Increased PO4 intakes led to increased calcium retention. For a ten mmol increase of PO4 intake, calcium retention increased by 0.28 mmol/day (p < 0.001). b) When analyses were stratified by calcium intake: For a ten mmol increase of PO4 intake, calcium retention increased by 0.31 and 0.13 mmol/day, for the low and high calcium intake studies, respectively (p<0.001 & p=0.035). c) When analyses were stratified by acidic and non-acidic PO4 supplements: For a ten mmol increase of PO4 intake, calcium retention increased by 0.31 and 0.21 mmol/day, respectively (p=0.115 & p<0.001).

Conclusions: All of the findings from this meta-analysis were contrary to the acid ash hypothesis. Higher PO4 intakes were associated with decreased urine calcium and increased calcium retention. This meta-analysis did not find evidence that PO4 contributes to demineralization of bone and bone calcium excretion in the urine. Dietary advice that dairy products, meats, and grains are “acidic” due to PO4 content and therefore detrimental to bone health needs reassessment.
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Greater intake of protein from meat enhances calcium retention from a low calcium diet in healthy postmenopausal women: A controlled feeding study

F. Roughead, L.K. Johnson, J.R. Hunt (Minnetonka Grand Forks, USA)

Objective: To determine whether dietary protein and calcium (Ca) interact to affect Ca retention and thus bone health.

Methods: In a randomized, controlled feeding study with a 2x2 factorial crossover design, healthy post-menopausal women (n=27), consumed either ~675 or ~1510 mg Ca/d, with both low and high protein (providing 10 and 20% energy) for 7 wk each, separated by a 3 wk washout period. After 3 wk of adaptation, the entire diet was extrinsically labeled with 47Ca, and isotope retention was monitored by whole body scintillation counting. Blood and urinary biomarkers of Ca and bone metabolism were measured.

Results: High, compared with low dietary protein significantly increased Ca retention from the low Ca diet (29.5 vs. 26.0% absorbed, P < 0.01), but not the high Ca diet (18% absorbed). For the low Ca diet, this nearly balanced a protein-related 0.5 mmol/d greater urinary Ca excretion. Protein-related calciuretic effects were independent of dietary Ca. Testing at 1, 2, 3, 5, and 7 wk revealed no long-term adaptation in urinary acidity or urinary Ca excretion. High compared with low dietary protein decreased urinary deoxypyridinoline and increased serum IGF-1 without affecting PTH, osteocalcin, bone-specific alkaline phosphatase, or tartrate-resistant acid phosphatase.

Conclusions: In healthy postmenopausal women, a moderate increase in dietary protein, from 10 to 20% of energy, slightly improved Ca absorption from a low Ca diet, nearly compensating for a slight increase in urinary Ca excretion. Under practical dietary conditions, increased dietary protein from animal sources was not detrimental to Ca balance or short term biomarkers of bone health.
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Welcome

18 years after the first Symposium on Nutritional Aspects of Osteoporosis in 1991, the topic remains a puzzling and difficult field of investigation, because the step from animal research to human trials confronts the variability of human preferences and food habits. In addition, capturing the effects on bone needs long-term investigations.

The 7th symposium will offer again an update and overview of the scientific efforts and achievements over the last years. It will gather the main investigators in the field and offer them an opportunity to meet and exchange. In fact, this symposium is still the only international meeting exclusively devoted to the interactions between nutrients and bone health.

We welcome you in Lausanne and wish you a fruitful meeting.

Peter Burckhardt
Bess Dawson-Hughes
Connie Weaver