

GRADUATE AND POSTDOCTORAL STUDIES

MCGILL UNIVERSITY



FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

ISABELLE GERMAIN
SCHOOL OF DIETETICS AND HUMAN NUTRITION

VITAMIN D RECOMMENDATIONS FOR CANADIAN ELDERLY:
AN EVALUATION OF ADEQUACY OF CURRENT CLINICAL PRACTICES
FOR NUTRITION AND SKELETAL HEALTH

March 16th 2017
9h15

CINE Building, Room 102
McGill University, Macdonald Campus

COMMITTEE:

Dr. Nancy Ross, ProDean, Department of Geography
Dr. Tim Johns, Departmental Chair, School of Dietetics and Human Nutrition
Dr. Hope Weiler, Supervisor, School of Dietetics and Human Nutrition
Dr. José A. Morais, Internal Examiner, MUHC-Montreal General Hospital
Dr. Katherine Gray-Donald, Committee Member, School of Dietetics and Human Nutrition
Dr. Valérie Orsat, External Member, Bioresource Engineering

Dr. Josephine Nalbantoglu, Dean of Graduate and Postdoctoral Studies
Members of the Faculty and Graduate Students
are invited to attend

ABSTRACT

Vitamin D is a key nutrient in maintenance of calcium homeostasis and contribution to bone health. Elderly populations living in long-term care (LTC) facilities of Canada face a higher risk of deficiency vitamin D intakes and sunlight exposure are limited. Endogenous synthesis and food intake of vitamin D can be cumulatively measured by serum 25-hydroxyvitamin D concentration (25(OH)D). The Institute of Medicine (IOM) revised the Dietary Reference Intakes (DRI) for Vitamin D and Calcium in 2011. The new DRIs replaced the Adequate Intake (AI) of 600 IU/d for vitamin D in adults with an Estimated Average Requirements (EAR: 400 IU/d) and a Recommended Dietary Allowance (RDA: 800 IU/d) for the elderly population of more than 70 y. Regardless of these recommendations, many elderly in Canada, in the community or in LTC, have low vitamin D status. Aging men are underrepresented in research looking at vitamin D and bone health. As men are living longer, and since they experience the highest morbidity and mortality following fractures, more investigation is required to describe the impact of low vitamin D status and its correction on bone health outcomes in advanced aging in men.

The global objectives of this thesis were to: (1) comprehensively assess dietary and supplemental intakes of vitamin D and its association with biomarkers of bone health in elderly men living in a LTC facility of the Montreal region (46°); (2) assess the impact of an 8-week supplementation regimen of 2000 IU/d of vitamin D₃ on 25(OH)D and markers of bone metabolism; (3) determine how much vitamin D₃ is required to sustain vitamin D status, using vitamin D₃ fortified foods.

The first study (objective 1) monitored food intake and sunlight exposure of 30 men over 16 weeks (October to March) at Ste-Anne's Hospital (Veterans Affairs Canada, Montréal, Québec). On average, participants were 85 y of age and relatively healthy. At baseline, midway and end of protocol, food intake was measured with 3-d weighed food records. Fasted blood samples were obtained to measure biomarkers of bone and mineral metabolism (serum 25(OH)D, parathyroid hormone (PTH), calcium, phosphate, osteocalcin (OC) and C-terminal telopeptide of collagen type 1 (CTX)) at each time point. Descriptive statistics and change over time were tested. Over 30% of participants, in the winter months, were below the 50 nmol/L of serum 25(OH)D concentrations suggested by the IOM. These elderly men consumed a mean of 280±120 IU/d of vitamin D, which represented 66% of that expected to be consumed foods served. Main carriers of vitamin D were meal supplements and in-house enriched milk. Serum 25(OH)D rose by summer and declined in the fall. PTH was lower in the spring compared to late summer. CTX and OC did not change over time.

Study 2 (objectives 2 and 3) consisted of a before after trial and randomized control trial (RCT) involving 60 veterans at Ste-Anne's Hospital. This 2 phase trial design took place from October to December (before after trial as a Loading Phase) and from January to July (RCT0-RCT24). The Loading Phase involved vitamin D₃ supplementation at 2000 IU/d (tablet), administered by the nursing staff, for 8 weeks. The RCT segment involved the randomization of the 60 participants to 3 groups: a Placebo group (0 IU/d), a 500 IU/d vitamin

D₃ group or a 1000 IU/d vitamin D₃ for which vitamin D₃ was integrated in bite size fortified foods (puddings, muffins or smoothies) served at breakfast for 24 weeks. The Placebo group received identical unfortified food items. Fasted blood samples were drawn to assess biomarkers of bone metabolism (serum 25(OH)D, PTH, calcium, phosphate, OC, CTX, osteoprotegerin and RANKL) at RCT – 8 weeks, RCT0 and RCT24. The RANKL:OPG ratio were calculated for each time point. At RCT0 and RCT24, peripheral dual-energy X-ray absorptiometry (pDXA), peripheral quantitative computed tomography (pQCT) and handgrip strength were performed on the non-dominant forearm. Differences over time and among groups in serum 25(OH)D, biomarkers as well as pQCT values, pDXA values and handgrip strength were tested using mixed model ANOVA for fixed effects of time and group and interactions. Results from Study 2 included a mean vitamin D intake of 291±144 IU/d and mean 25(OH)D concentration of 56.1±13.8 nmol/L with no differences among groups at baseline. During the 8-wk Loading Phase, the supplementation of 2000 IU/d of vitamin D₃ raised serum 25(OH)D to a mean value of 65 nmol/L in all groups. In the RCT segment of the trial, the groups receiving 500 IU/d or 1000 IU/d were able to maintain serum 25(OH)D above 65 nmol/L. After the 24 weeks of vitamin D₃ fortification, serum 25(OH)D mean values increased to 74±16.5 nmol/L in the 500 IU/d group and to 79±17.2 nmol/L in the 1000 IU/d group. After 8 of the 24 weeks, the Placebo group reverted back to the values of 25(OH)D concentrations reported at the beginning of the study, demonstrating that dietary intakes alone were insufficient to maintain 25(OH)D concentrations. Biomarkers of bone metabolism measured were all maintained over time. Results from the pQCT demonstrated a decline over time in trabecular vBMD for the group receiving 500 IU/d and in vBMD at the diaphysis for the group receiving 1000 IU/d. Total bone area measured in the diaphysis improved from 177.0±27.3 to 186.8±31.9 mm³ in the 1000 IU/d group. Muscle area decreased in all groups over time. Muscle density was maintained over time. Supplementation of 1000 IU/d modestly improved areal bone mineral density (aBMD) and maintained handgrip strength over time. Participants preferred consuming fortified foods compared to tablets.

In conclusion, these studies suggest that vitamin D intakes are insufficient for elderly men in LTC facilities and that supplementation is required to achieve and maintain healthy vitamin D status. Despite the lack of improvement vBMD values, the group receiving 1000 IU/d of vitamin D₃ improved bone area of the proximal 1/3th forearm suggesting remodeling with incomplete mineralization. In all groups, muscle area decreased but muscle density was maintained over time. As handgrip strength was improved in the 1000 IU/d group, this supports that vitamin D₃ could positively influence muscle strength and, possibly reduce the risk of falls and subsequent fractures. Additional research will be needed to better understand the interrelationships among vitamin D and musculoskeletal health in elderly men residing in LTC.

CURRICULUM VITAE

UNIVERSITY EDUCATION

1997 – 2001 Master of Science in Human Nutrition – School of Dietetics and Human Nutrition, McGill Univ.

The evaluation of the Nutritional Outcomes of Advanced Nutritional Care for the Treatment of Dysphagia in the Elderly

Co-supervisors: Dr. Katherine Gray-Donald and Dr. Hosahalli Ramaswamy

1990 – 1995 Bacc. ès Sciences – Programme de Nutrition, Univ. de Montréal

EMPLOYMENT

2016 - Conseillère-cadre aux Services thérapeutiques et réadaptation physique, CIUSSS de l'Ouest de l'Île de Montréal

2014 – 2016 Chef de nutrition clinique, Hôpital Sainte-Anne

2014 - Présidente Association professionnelle des nutritionnistes experts en dysphagie

2002 – 2016 Nutritionniste clinicienne, Vigi Santé Ltée

1995 – 2014 Nutritionniste clinicienne, Hôpital Sainte-Anne

AWARDS

Fellowship in the area of Mobility in Aging of 55,000\$/y for 5 years, Canadian Institutes of Health Research (IRSC-CIHR)

Research Grants, Canadian Foundation for Dietetic Research (2008: 15,000\$ and 2012: 20,000\$)

Bourses de recherche, Producteurs d'œufs du Canada et de la Fédération des producteurs d'œufs de consommation du Québec (2010: 12,075\$ and 5000\$)

Prix New Researcher, Am. Society of Bone and Mineral Research (March 2010)

Prix Rayonnement, Hôpital Ste-Anne (Juin 2010)

Prix Andrée Beaulieu - Excellence en communication scientifique, Fédération des producteurs de porcs du Québec – Article La pratique diététique fondée sur les données probantes : un virage incontournable! published in Nutrition Science en évolution (2009)

Prix des Producteurs laitiers du Canada – Mérite annuel en diététique – Corporate website www.apned.info, Nutritional care in dysphagia (2007)

Meilleure affiche clinique - 11e Journée de recherche annuelle – Gériatrie, Université McGill (2006)

Prix du Leadership en Service & Innovation - Programme de dysphagie, Hôpital Sainte-Anne (2001)

Prix de l'Association des Hôpitaux du Québec - Programme de dysphagie, Hôpital Sainte-Anne (1998)

Prix Milupa – Best academic accomplishment in nutrition and elderly (1995)

Bourse de l'Association des fournisseurs et restaurateurs du Québec Inc, AFRQ (1994)

PUBLICATIONS

1. Germain I. et al. Insufficient vitamin D intake and low vitamin D status in men over 80 y of age: Intervention is required to meet dietary targets in long-term care facilities *Vitamins & Minerals* 2:113. (2013) doi: 10.4172/vms.1000113
2. Germain I. La vitamine D et la douleur. Lecture complémentaire au Congrès des Médecins omni-praticiens du Québec (2012)
3. Germain I et Presse N. La pratique diététique fondée sur les données probantes: un virage incontournable! *Nutrition – Science en évolution* (2009)
4. Germain I, Dufresne T, Gray-Donald K. A novel dysphagia diet improves the nutrient intake of institutionalized elders. *Journal of American Dietetic Association* 2006 Oct; 106 (10):1614-23.
5. Germain I, Dufresne T, Ramaswamy HS. Rheological characterization of thickened beverages used in the treatment of dysphagia. *Journal of Food Engineering* 2006 73, 1, 64-74.

PRESENTATIONS

1. Germain I and Weiler H. Vitamine D: Besoins, apports et impacts sur la santé de la personne âgée au Canada. Colloque «Nutrition et personne âgée II : pour savourer chaque secondes» (2008) Institut universitaire de gériatrie de Montréal
2. Germain I and Weiler H. Programme de recherche: vitamine D - Impacts du statut en vitamine D sur la santé de vétérans canadiens (2008) Forum Qualité Recherche – Hôpital Sainte-Anne
3. Germain I. La vitamine D chez les anciens combattants de l'Hôpital Sainte-Anne: résultats de 2 études pilotes (2011) Annual Meeting, Dietitians of Canada
4. Germain I, Vanstone C, Hazell T et al. Impact of vitamin D3 fortified foods on vitamin D status and radial bone mineral density in elderly men during the winter and spring seasons: A randomized controlled trial (2013) Annual Meeting, Canadian Association
5. Germain I, Vanstone C, Hazell T et al. Des aliments fortifiés en vitamine D aident à prévenir le déclin hivernal du taux de vitamine D et la densité osseuse chez nos vétérans (2014) Forum Qualité Recherche – Hôpital Sainte-Anne