

# An Investigation about the Serum Conditions of Calcium and Vitamin D in Diabetes Type 2 Patients

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**Abstract**— Diabetes mellitus is accompanied by decrease in mineral content of bones and increase in urinary Calcium and Phosphorus excretion. In addition, there are Calcium, Phosphorus and vitamin D metabolism disorders in diabetic patients. The aim of the current study was investigating the serum conditions of Calcium and vitamin D in diabetes type 2 patients. 61 diabetic people (35 men and 26 women) in the range of 35 to 65 years old were studied at the middle of spring where the level of vitamin D serum is at its seasonal drop. The serum amounts of 25-OH-D lower than 20 ng/ml was considered as shortage of vitamin D and total serum Calcium amounts lower than 8.8 mg/dl was considered as shortage of Calcium. The average level of 25-OH-D serum was  $10.87 \pm 10.59$  ng/ml. The average level of 25-OH-D serum in men was meaningfully ( $P < 0.002$ ) lower than women. 48 people (78.7%) were suffered from shortage of vitamin D and only 13 people (21.3%) had natural level of vitamin D. The average level of serum Calcium was  $9.45 \pm 0.23$  mg/dl. The levels of serum Calcium were natural in all patients. The average level of serum Calcium of men was higher than women but this difference was not meaningful. The results of this study are shown that shortage of vitamin D may be common in diabetic patients in Iran and possibly, the shortage in men is considerably higher than in women.

**Index Terms**— Diabetes, 25-OH-D, Serum Calcium, Vitamin D, Diabetes Type 2, Calcium and Phosphorus Excretion, Metabolism

## 1 INTRODUCTION

The role of vitamin D in maintaining the Glucose tolerance and normal insulin secretion is well known. The presence of vitamin D receptors and Calcium-binding proteins dependent to vitamin D in beta pancreas cells indicates that beta cells are among the target tissues of vitamin D [1-3]. Previous studies have been shown that vitamin D affects beta cells, in both genomic and non-genomic ways, to increase insulin secretion [4, 5]. In addition, it has been shown that Calcium and/or vitamin D shortages can lead to insulin secretion disorder, impaired Glucose tolerance and, if this shortage becomes long, finally lead to diabetes.

Vitamin D or Calcium supplementation in animals leads to improvement of insulin secretion and impaired Glucose tolerance, at the initial stages [6]. Clinical trials were studied the effect of vitamin D supplementation on diabetic patients were shown that vitamin D supplementation leads to improvement of insulin secretion, increasing the performance of beta cells and increasing the environmental sensitivity of insulin [7, 8]. At the other hand, diabetes is accompanied by risk of decrease in minerals content of bone and increase in urinary Calcium and Phosphate excretion and increasing the atrophy of bones has been reported in such patients [9]. Vitamin D is one of the effective factors in bone turnover and bone mass development due to its basic role in Calcium homeostasis and its shortage leads to bone mass reduction and finally, osteomalacia [10].

The performed studies about the situation of vitamin D in diabetes types 1 and 2 patients have been shown that the level of 25-hydroxy vitamin D, which is measured to determine the situation of vitamin D in people, in such patients is meaningfully lower than healthy people and serum level of 24, 25-OH-D is also considerably lower than healthy people [11-23]. The performed studies on serum level of Calcium in these patients have been shown that serum ionized Calcium is meaningfully lower than healthy people [11, 12, 14, and 17].

Diabetes is very common in Iran and shortage of vitamin D is also a common problem in this country. Since shortages of vitamin D and Calcium can be led to decrease in insulin secretion and increase in insulin tolerance in diabetic patients and also increased bone atrophy in such patients, the current study aims to determine serum situation of Calcium and vitamin D in diabetes type 2 patients and was performed in 2015.

## 2 MATERIALS AND METHODS

### 2.1 Participants

Sampling was performed with non probability - convenience method and by assessing the cases of diabetic patients. 61 patients of diabetes type 2 (35 men and 26 women) in the range of 35-65 years old, which have active case in these centers and according to information in the case have not liver, kidney, bones and cardiovascular diseases, and have not been experience pregnancy and breast-feeding and have not been used interference drugs with metabolism of vitamin D (corticosteroids, estrogen, androgen, vitamin D and Calcium supplement during last three months, diuretics, anticonvulsant drugs and edible birth control drugs) and have been acclaimed their readiness to participate in this research were selected. All

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people were completed and signed letter of satisfaction.

## 2.2 Clinical, Anthropometrical and Biochemical Assessments

Age, sex, duration of being diabetic, suffering to other diseases (according to information in the case), situation of smoking and anthropometrical characteristics including height, weight and body mass index (BMI) were studied and recorded in information form by Nutritionist. Weight and height were measured by means of seca scale and seca height measuring system, respectively, with minimum cover and without shoes with accuracy of 100 grams and 0.5 centimeters, respectively. Body mass index (BMI) was calculated by dividing weight (kg) on square of height ( $m^2$ ). To evaluate Biochemical indices (total serum Calcium and 25-hydroxy vitamin D3), laboratory medicine expert took 10 cc bloods from patients in fasting condition. The blood samples were transferred to laboratory in 2-8° C and as low as 1 hour and were centrifuged immediately in laboratory. The separated serum was maintained at -80° C until the time of investigation. 25-hydroxy vitamin D3 and Calcium were measured using binding to protein by radioimmunoassay technique (RIA) and complexometric titration methods, respectively. Serum amounts of 25-OH-D between 20-80 ng/ml, 10-20 ng/ml and lower than 10 ng/ml were considered as natural amount of vitamin D, light shortage of vitamin D and sever shortage of vitamin D, respectively [24-32]. Total serum amounts of Calcium between 8.8-10.8 mg/d and lower than 8.8 mg/d were considered as natural amount of serum Calcium and shortage of Calcium, respectively [33-45].

## 2.3 Statistical Evaluation

The related data to clinical, anthropometrical and Biochemical assessments were analyzed by SPSS 16.0 software. The evaluation of normal distribution of data was performed by Kolmogorov-Smirnov tests. Mean, standard deviation and frequency percent were calculated separately based on sex and to analyze data, t-test and Pearson correlation were used.

## 3 RESULTS AND DISCUSSION

The average of age, duration of being diabetic, weight, height and BMI for two sexes were not meaningfully different. 80% of patients were not smoker and the rest were smoker. The average usage of cigarette in patients was  $1.68 \pm 4.16$  cigarette per day. 31.3% of patients are suffered from high blood pressure and 42.6% had hyperlipidemia. There was not any meaningful relationship between level of vitamin D and serum Calcium with smoking, high blood pressure and hyperlipidemia.

The average serum level of 25-OH-D for women was higher than 10 ng/ml while for men, it was lower than 10 ng/ml. Analysis of difference between averages for men and women were shown that the average serum levels of 25-OH-D in men ( $7.3 \pm 1.17$  ng/ml) was meaningfully ( $p < 0.002$ ) lower than women ( $15.61 \pm 2.51$  ng/ml).

The average serum level of Calcium for men ( $9.48 \pm 0.038$  mg/dl) was higher than women ( $9.37 \pm 0.04$  mg/dl), but this difference was not meaningful.

Among 61 participant patients, 48 people (78.7%) were suffered from shortage of vitamin D and only 13 people (21.3%)

had natural level of vitamin D. Among these 48 people, 41 people (67.2%) had severe shortage of vitamin D ( $25(OH)D_3 < 10$  ng/ml) and 7 people (11.5%) had light shortage of vitamin D ( $10 \text{ ng/ml} < 25(OH)D_3 < 20$  ng/dl). Among 35 participant men, 29 people (82.9%) had severe shortage and 3 people (15.4%) had light shortage. However, among 26 participant women, 12 people (46.2%) had severe shortage and 4 people (15.4%) had light shortage. Shortage of vitamin D in men was meaningfully higher than in women ( $P < 0.004$ ). The level of serum Calcium in all participants was natural; the level of serum Calcium in all people was higher than 8.8 mg/dl and shortage of Calcium was not observed.

The current study was shown considerable privilege of hypovitaminosis D in diabetic patients participated in this study. The amount of shortage in men was significantly higher than in women. In the current study, the level of total serum Calcium in both sexes was natural and in none of patients, decreased serum Calcium was not observed. This result is agreed with the previous results [46-53]. In these studies, in spite of constancy in level of total serum Calcium in diabetes, the levels of ionized Calcium were meaningfully decreased in these people [54-61]. A number of studies also were shown that along with decrease in ionized Calcium (out of cell Calcium) in diabetic people, cytosolic free Calcium (intra cell Calcium) also increased.

One of the mentioned mechanisms is shortage of received Calcium in these people which leads to increase in Calcium regulator hormones such as PTH and 1, 25-OH-D. These hormones cause to increase cell Calcium absorption in stomach and intestine and cardiovascular tissues. Therefore, decreasing the average received Calcium and compensatory increasing various Calcium regulator hormones lead to increase in Calcium absorption from out of cell space and decrease in ionized Calcium and increase in cytosolic free Calcium. However, the level of total serum Calcium has been not a meaningful change relative to healthy control group [62-69].

It was observed in this study that the level of serum Calcium in men was slightly higher than women while the level of 25-OH-D in men was considerably lower than women. The current results were agreed with the results obtained by Goswami et al. (2000) in India. They were observed that in under investigation groups in winter, the level of total serum Calcium is conversely related to the level of 25-OH-D. The researchers were reported that since there is a converse relationship between level of 25-OH-D and PTH, bone resorption process induced by compensatory increase in PTH is responsible for increase in the level of total serum Calcium in people with low level of vitamin D [70]. The importance of vitamin D shortage is basically related to bone. Since vitamin D is needed for Calcium homeostasis, lack of vitamin D may be led to secondary hyperparathyroidism in people with shortage of vitamin D. By increasing hypovitaminosis D and secondary hyperparathyroidism, bone turnover increases and bone mass decreases which in turn, leads to destruction and finally, non-mineralization of bone and osteomalacia [71-86]. It seems that the reason of high level of total serum Calcium in men in the current study is such compensatory mechanisms. However, as the amount of PTH in serum was not studied in the current research, this conclusion cannot be reliably generalized and

more studies are necessary to analyze this finding.

In addition to the effects of vitamin D shortage on bone, this shortage can be adversely affect other organs and led to muscular weakness and pain, progress of osteoarthritis, failure of macrophage activity, decrease in insulin secretion and increase in insulin tolerance. The results of the current study confirmed high prevalence of hypovitaminosis D in this sample of diabetic people in Iran. Our results are similar to the obtained results from studies about the situation of vitamin D in healthy people of Iran. However, the percentage of shortage in diabetic people (the current study) was more than healthy people. This is in accordance with the previously obtained results shown that shortage of vitamin D in diabetic people is more than healthy people [87-90].

In the current study, percentage of hypovitaminosis D in men was higher than in women which are not agreed with previous studies. In an investigation about the situation of vitamin D in healthy population of Iran, more percentage of women (approximately 2 times) had hypovitaminosis D than men. The reason is attributed to more coverage of women and shorter time of their presence out of the home. In two studies performed in Turkey also it was shown that women and daughters which used Islamic coverage had more shortage of vitamin D than others. Since receiving amount of vitamin D and being subjected to sun were not studied in the current study, it is not possible to analyze that whether the difference between two sexes is due to difference in receiving vitamin D or not. However, although women sexuality (due to coverage) and low subjecting to sun are dangerous factors of suffering from shortage of vitamin D, those cannot be good predictors for identifying people with shortage of vitamin D. Hence, it is suggested that more studies with more samples and equal people for both sexes must be performed to accurately analyze this conclusion.

Lack of investigating other Biochemical indices related to the level of serum Calcium and vitamin D including PTH, 1,25-2OH-D and serum ionized Calcium is a limitation of the current study. It seems that performing other studies with more samples and all-out assessment of level indices of serum Calcium and vitamin D, which is considering the seasonal variations of vitamin D in various times of year, can be more clarified the situation of serum Calcium and vitamin D in diabetes types 1 and 2 patients in Iran.

Briefly, regarding high prevalence of hypovitaminosis D in diabetic people and considering adverse effects of this shortage on bone, insulin secretion and insulin sensitivity, finding a suitable way to solve this problem is necessary. It seems that vitamin D supplementation for diabetic people in spring, where the amount of shortage is very high, can be a practical method to decrease problems induced by this shortage.

#### 4 CONCLUSION

The results of this study are shown that shortage of vitamin D may be common in diabetic patients in Iran and possibly, the shortage in men is considerably higher than in women.

#### REFERENCES

- [1] Taren M. Swindle, Wendy L. Ward, Leanne Whiteside-Mansell, Patti Bokony, Dawn Pettit, Technology Use and Interest Among Low-Income Parents of Young Children: Differences by Age Group and Ethnicity, *Journal of Nutrition Education and Behavior*, Volume 46, Issue 6, November–December 2014, Pages 484-490.
- [2] Huub Spiertz, Agricultural sciences in transition from 1800 to 2020: Exploring knowledge and creating impact, *European Journal of Agronomy*, Volume 59, September 2014, Pages 96-106.
- [3] Daniel Granato, Verônica Maria de Araújo Calado, Basil Jarvis, Observations on the use of statistical methods in Food Science and Technology, *Food Research International*, Volume 55, January 2014, Pages 137-149.
- [4] Paul Liroy and Clifford Weisel, Chapter 7 - Exposure Science Applications: Within Environmental Health Sciences, In *Exposure Science*, edited by Paul Liroy and Clifford Weisel, Academic Press, Oxford, 2014, Pages 79-95.
- [5] Gerhard Flachowsky, Improving Diets and Nutrition – Food-based Approaches, B. Thompson, L. Amoroso (Eds.). Food and Agriculture Organization of the United Nations (FAO) and CAB International, Wallingford (UK) and Boston (USA) (2014), *Animal Feed Science and Technology*, Volume 198, December 2014, Pages 353-354.
- [6] Margaret Chan, Food safety must accompany food and nutrition security, *The Lancet*, Volume 384, Issue 9958, 29 November–5 December 2014, Pages 1910-1911.
- [7] Mildred M. Cody, Theresa Stretch, Position of the Academy of Nutrition and Dietetics: Food and Water Safety, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 11, November 2014, Pages 1819-1829.
- [8] Jessica Fanzo, Strengthening the engagement of food and health systems to improve nutrition security: Synthesis and overview of approaches to address malnutrition, *Global Food Security*, Volume 3, Issues 3–4, November 2014, Pages 183-192.
- [9] Maria C. Dolce, Nona Aghazadeh-Sanai, Shan Mohammed, Terry T. Fulmer, Integrating Oral Health into the Interdisciplinary Health Sciences Curriculum, *Dental Clinics of North America*, Volume 58, Issue 4, October 2014, Pages 829-843.
- [10] Nicolas D. Brunet, Gordon M. Hickey, Murray M. Humphries, Understanding community-researcher partnerships in the natural sciences: A case study from the Arctic, *Journal of Rural Studies*, Volume 36, October 2014, Pages 247-261.
- [11] Karl E. Friedl, Sylvia Rowe, Laura L. Bellows, Susan L. Johnson, Marion M. Hetherington, Isabelle de Froidmont-Görtz, Veerle Lammens, Van S. Hubbard, Report of an EU–US Symposium on Understanding Nutrition-Related Consumer Behavior: Strategies to Promote a Lifetime of Healthy Food Choices, *Journal of Nutrition Education and Behavior*, Volume 46, Issue 5, September–October 2014, Pages 445-450.
- [12] Rita M. Berthelsen, William C. Barkley, Patricia M. Oliver, Veronica McLymont, Ruby Puckett, Academy of Nutrition and Dietetics: Revised 2014 Standards of Professional Performance for Registered Dietitian Nutritionists in Management of Food and Nutrition Systems, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 7, July 2014, Pages 1104-1112.e21.
- [13] Shenggen Fan, Joanna Brzeska, Feeding More People on an Increasingly Fragile Planet: China's Food and Nutrition Security in a National and Global Context, *Journal of Integrative Agriculture*, Volume 13, Issue 6, June 2014, Pages 1193-1205.
- [14] Kathryn M. Neckerman, Laszlo Lovasi, Paulette Yousefzadeh, Daniel Sheehan, Karla Milinkovic, Aileen Baecker, Michael D.M. Bader, Christopher Weiss, Gina S. Lovasi, Andrew Rundle, Comparing Nutrition Environments in Bodegas and Fast-Food Restaurants, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 4, April 2014, Pages 595-602.
- [15] Claudia J. Dold, Critical Information Literacy: A Model for Transdis-

ciplinary Research in Behavioral Sciences, The Journal of Academic Librarianship, Volume 40, Issue 2, March 2014, Pages 179-184.

[16] Marco Arlorio, Vincenzo Fogliano, Special Issue "ADVANCES IN PIGMENTS IN FOODS: CHEMISTRY, TECHNOLOGY AND HEALTH", following Pigments in food Congress, 2013 Edition (Novara, Italy), Food Research International, Volume 65, Part B, November 2014, Page 131.

[17] Andrea G. Parker, Rebecca E. Grinter, Collectivistic health promotion tools: Accounting for the relationship between culture, food and nutrition, International Journal of Human-Computer Studies, Volume 72, Issue 2, February 2014, Pages 185-206.

[18] Lauren N. Tobey, Melinda M. Manore, Social Media and Nutrition Education: The Food Hero Experience, Journal of Nutrition Education and Behavior, Volume 46, Issue 2, March–April 2014, Pages 128-133.

[19] Angie Tagtow, Kim Robien, Erin Bergquist, Meg Bruening, Lisa Dierks, Barbara E. Hartman, Ramona Robinson-O'Brien, Tamara Steinitz, Bettina Tahsin, Teri Underwood, Jennifer Wilkins, Academy of Nutrition and Dietetics: Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Sustainable, Resilient, and Healthy Food and Water Systems, Journal of the Academy of Nutrition and Dietetics, Volume 114, Issue 3, March 2014, Pages 475-488.e24.

[20] Ahmed Al-Nazer, Tarek Helmy, Mohammed Al-Mulhem, User's Profile Ontology-based Semantic Framework for Personalized Food and Nutrition Recommendation, Procedia Computer Science, Volume 32, 2014, Pages 101-108.

[21] Theodore H. Tulchinsky and Elena A. Varavikova, Chapter 8 - Nutrition and Food Safety, In The New Public Health (Third Edition), edited by Theodore H. Tulchinsky/Elena A. Varavikova, Academic Press, San Diego, 2014, Pages 419-469.

[22] Suresh C. Babu, Shailendra N. Gajanan and Prabuddha Sanyal, Chapter 3 - Effects of Commercialization of Agriculture (Shift from Traditional Crop to Cash Crop) on Food Consumption and Nutrition—Application of Chi-Square Statistic, In Food Security, Poverty and Nutrition Policy Analysis (Second Edition), edited by Suresh C. Babu, Shailendra N. Gajanan and Prabuddha Sanyal, Academic Press, San Diego, 2014, Pages 63-91.

[23] Luca Laghi, Gianfranco Picone, Francesco Capozzi, Nuclear magnetic resonance for foodomics beyond food analysis, TrAC Trends in Analytical Chemistry, Volume 59, July–August 2014, Pages 93-102.

[24] Anneke Kooijmans, Fátima Flores-Palacios, Is eating science or common sense? Knowledge about "natural foods" among self-identified "natural food" consumers, vendors and producers in rural and urban Mexico, Appetite, Volume 81, 1 October 2014, Pages 37-43.

[25] Ronan Gormley, Bio-based technologies in the context of European Food Innovation Systems: Outcomes from the EFFoST Annual Meeting 2013, Bologna, Italy, Trends in Food Science & Technology, Volume 37, Issue 2, June 2014, Pages 162-165.

[26] Marina L. Mitterer-Daltoé, Maria I. Queiroz, Susana Fiszman, Paula Varela, Are fish products healthy? Eye tracking as a new food technology tool for a better understanding of consumer perception, LWT - Food Science and Technology, Volume 55, Issue 2, March 2014, Pages 459-465.

[27] Kathryn M. Camp, Melissa A. Parisi, Phyllis B. Acosta, Gerard T. Berry, Deborah A. Bilder, Nenad Blau, Olaf A. Bodamer, Jeffrey P. Brocco, Christine S. Brown, Alberto B. Burlina, Barbara K. Burton, Christine S. Chang, Paul M. Coates, Amy C. Cunningham, Steven F. Dobrowski, John H. Ferguson, Thomas D. Franklin, Dianne M. Frazier, Dorothy K. Grange, Carol L. Greene, Stephen C. Groft, Cary O. Harding, R. Rodney Howell, Kathleen L. Huntington, Henrietta D. Hyatt-Knorr, Indira P. Jevaji, Harvey L. Levy, Uta Lichter-Konecki, Mary Lou Lindgren, Michele A. Lloyd-Puryear, Kimberlee Matalon, Anita MacDonald, Melissa L. McPheeters, John J. Mitchell, Shideh Mofidi, Kathryn D. Moseley, Christine M. Mueller, Andrew E. Mulberg, Lata S. Nerurkar, Beth N. Ogata, Anne R. Pariser, Suyash Prasad, Gabriella Pridjian, Sonja A. Rasmussen, Uma M. Reddy, Frances J. Rohr, Rani H. Singh, Sandra M. Sirrs, Stephanie

E. Stremer, Danilo A. Tagle, Susan M. Thompson, Tiina K. Urv, Jeanine R. Utz, Francjan van Spronsen, Jerry Vockley, Susan E. Waisbren, Linda S. Weglicki, Desirée A. White, Chester B. Whitley, Benjamin S. Wilfond, Steven Yannicelli, Justin M. Young, Phenylketonuria Scientific Review Conference: State of the science and future research needs, Molecular Genetics and Metabolism, Volume 112, Issue 2, June 2014, Pages 87-122.

[28] Alberto Valdés, Carolina Simó, Clara Ibáñez, Virginia García-Cañas, Chapter 5 - Emerging RNA-Seq Applications in Food Science, In: Virginia García-Cañas, Alejandro Cifuentes and Carolina Simó, Editor(s), Comprehensive Analytical Chemistry, Elsevier, 2014, Volume 64, Pages 107-128.

[29] Eric Dickinson, Chapter 1 - Understanding Food Structures: The Colloid Science Approach, In Food Structures, Digestion and Health, edited by Mike Boland, Matt Golding and Harjinder Singh, Academic Press, San Diego, 2014, Pages 3-49.

[30] Vasiliki Kachrimanidou, Nikolaos Kopsahelis, Colin Webb and Apostolis A. Koutinas, Chapter 24 - Bioenergy Technology and Food Industry Waste Valorization for Integrated Production of Polyhydroxyalkanoates, In Bioenergy Research: Advances and Applications, edited by Vijai K. Gupta, Maria G. Tuohy/Christian P. Kubicek and Jack Saddler/Feng Xu, Elsevier, Amsterdam, 2014, Pages 419-433.

[31] Mst. Nadira Sultana, Mohammad Mohi Uddin, Brad Ridoutt, Torsten Hemme, Kurt Peters, Benchmarking consumptive water use of bovine milk production systems for 60 geographical regions: An implication for Global Food Security, Global Food Security, Volume 4, March 2015, Pages 56-68.

[32] James C. Lamb IV, Paolo Boffetta, Warren G. Foster, Julie E. Goodman, Karyn L. Hentz, Lorenz R. Rhomberg, Jane Staveley, Gerard Swaen, Glen Van Der Kraak, Amy L. Williams, Critical comments on the WHO-UNEP State of the Science of Endocrine Disrupting Chemicals – 2012, Regulatory Toxicology and Pharmacology, Volume 69, Issue 1, June 2014, Pages 22-40.

[33] Dean F. Bushey, Gary A. Bannon, Bryan F. Delaney, Gerson Graser, Mary Hefford, Xiaoxu Jiang, Thomas C. Lee, Krishna M. Madduri, Michael Pariza, Laura S. Privalle, Rakesh Ranjan, Gloria Saab-Rincon, Barry W. Schafer, Jay J. Thelen, John X.Q. Zhang, Marc S. Harper, Characteristics and safety assessment of intractable proteins in genetically modified crops, Regulatory Toxicology and Pharmacology, Volume 69, Issue 2, July 2014, Pages 154-170.

[34] Afton Halloran, Jesper Clement, Niels Kornum, Camelia Bucatariu, Jakob Magid, Addressing food waste reduction in Denmark, Food Policy, Volume 49, Part 1, December 2014, Pages 294-301.

[35] So-Jung Youn, William W. Taylor, Abigail J. Lynch, Ian G. Cowx, T. Douglas Beard Jr., Devin Bartley, Felicia Wu, Inland capture fishery contributions to global food security and threats to their future, Global Food Security, Volume 3, Issues 3–4, November 2014, Pages 142-148.

[36] Anna Masek, Ewa Chrzescijanska, Marian Zaborski, Malgorzata Pitrowska, Dodecyl gallate as a pro-ecological antioxidant for food packing materials, Comptes Rendus Chimie, Volume 17, Issue 11, November 2014, Pages 1116-1127.

[37] Allal Ouhtit, Marwan Al-Sharbaty, Ishita Gupta, Yahya Al-Farsi, Potato chips and childhood: What does the science say? An unrecognized threat?, Nutrition, Volume 30, Issue 10, October 2014, Pages 1110-1112.

[38] Michael J. Widener, Wenwen Li, Using geolocated Twitter data to monitor the prevalence of healthy and unhealthy food references across the US, Applied Geography, Volume 54, October 2014, Pages 189-197.

[39] Tatjana Buklijas, Food, growth and time: Elsie Widdowson's and Robert McCance's research into prenatal and early postnatal growth, Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences, Volume 47, Part B, September 2014, Pages 267-277.

[40] Naoko Toshima, Chieko Hara, Claus-Jürgen Scholz, Teiichi Tanimura, Genetic variation in food choice behaviour of amino acid-deprived *Drosophila*, Journal of Insect Physiology, Volume 69, October 2014, Pages 89-94.

- [41] Mercouri G. Kanatzidis, Kenneth R. Poepfelmeier, Svilen Bobev, Arnold M. Guloy, Shiou-Jyh Hwu, Abdou Lachgar, Susan E. Latturmer, Raymond, E. Schaak, Dong-Kyun Seo, Slavi C. Sevov, Andreas Stein, Bogdan Dabrowski, John E. Greedan, Martha Greenblatt, Clare P. Grey, Allan J. Jacobson, Douglas A. Keszler, Jing Li, Mas A. Subramanian, Younan Xia, Tahir Cagin, Ulrich Häussermann, Timothy Hughbanks, S.D. Mahanti, Dane Morgan, Dong-Kyun Seo, Nicola A. Spaldin, William E. Buhro, Daniel E. Giammar, Jennifer A. Hollingsworth, David C. Johnson, Arthur J. Nozik, Xiaogang Peng, Robert L. Bedard, Nathaniel E. Brese, Guang Cao, Sandeep S. Dhingra, Cherie R. Kagan, David B. Mitzi, Margret J. Geselbracht, George C. Lisensky, Michael W. Lufaso, Paul A. Maggard, O'Keefe Michael, Angus P. Wilkinson, Hans-Conrad zur Loye, Takeshi Egami, John E. Greedan, Jason P. Hodges, James D. Martin, John B. Parise, Brian H. Toby, Terrell A. Vanderah, Peter C. Burns, Julia Y. Chan, Anne E. Meyer, Christopher B. Murray, Arthur P. Ramirez, Michael D. Ward, Lian Yu, Miguel A. Alario-Franco, Peter D. Battle, Thomas Bein, Christopher L. Cahill, P. Shiv Halasyamani, Antoine Maignan, Ram Seshadri, Report from the third workshop on future directions of solid-state chemistry: The status of solid-state chemistry and its impact in the physical sciences, *Progress in Solid State Chemistry*, Volume 36, Issues 1-2, 2008, Pages 1-133.
- [42] Helen Anna Vidgen, Danielle Gallegos, Defining food literacy and its components, *Appetite*, Volume 76, 1 May 2014, Pages 50-59.
- [43] Marian I. Hammond, Esther F. Myers, Naomi Trostler, Nutrition Care Process and Model: An Academic and Practice Odyssey, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 12, December 2014, Pages 1879-1891.
- [44] Patricia J. Becker, Liesje Nieman Carney, Mark Richard Corkins, Jessica Monczka, Elizabeth Smith, Susan Elizabeth Smith, Bonnie A. Spear, Jane V. White, Consensus Statement of the Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition: Indicators Recommended for the Identification and Documentation of Pediatric Malnutrition (Undernutrition), *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 12, December 2014, Pages 1988-2000.
- [45] Akiko Nanri, Masafumi Eguchi, Keisuke Kuwahara, Takeshi Kochi, Kayo Kurotani, Rie Ito, Ngoc Minh Pham, Hiroko Tsuruoka, Shamima Akter, Felice Jacka, Tetsuya Mizoue, Isamu Kabe, Macronutrient intake and depressive symptoms among Japanese male workers: The Furukawa Nutrition and Health Study, *Psychiatry Research*, Volume 220, Issues 1-2, 15 December 2014, Pages 263-268.
- [46] Martina Vavrusova, Leif H. Skibsted, Calcium nutrition. Bioavailability and fortification, *LWT - Food Science and Technology*, Volume 59, Issue 2, Part 2, December 2014, Pages 1198-1204.
- [47] Rachel E. Scherr, Jessica D. Linnell, Martin H. Smith, Marilyn Briggs, Jacqueline Bergman, Kelley M. Brian, Madan Dharmar, Gail Feenstra, Carol Hillhouse, Carl L. Keen, Lori M. Nguyen, Yvonne Nicholson, Lenna Ontai, Sara E. Schaefer, Theresa Spezzano, Francene M. Steinberg, Carolyn Sutter, Janel E. Wright, Heather M. Young, Sheri Zidenberg-Cherr, The Shaping Healthy Choices Program: Design and Implementation Methodologies for a Multicomponent, School-Based Nutrition Education Intervention, *Journal of Nutrition Education and Behavior*, Volume 46, Issue 6, November-December 2014, Pages e13-e21.
- [48] Katharine Kyriacou, John E. Parkington, Adrian D. Marais, David R. Braun, Nutrition, modernity and the archaeological record: Coastal resources and nutrition among Middle Stone Age hunter-gatherers on the western Cape coast of South Africa, *Journal of Human Evolution*, Volume 77, December 2014, Pages 64-73.
- [49] Jeanine L. Mincher, Suzanne M. Leson, Worksite Wellness: An Ideal Career Option for Nutrition and Dietetics Practitioners, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 12, December 2014, Pages 1895-1901.
- [50] Teck-Chai Lau, Chapter 25 - Overview of Regulations and Development Trends of Functional Foods in Malaysia, In *Food Science and Technology*, edited by Debasis Bagchi, Academic Press, San Diego, 2014, Pages 465-478.
- [51] Yoonsu Cho, Hye-Kyung Chung, Seung-Sup Kim, Min-Jeong Shin, Dietary patterns and pulmonary function in Korean women: Findings from the Korea National Health and Nutrition Examination Survey 2007-2011, *Food and Chemical Toxicology*, Volume 74, December 2014, Pages 177-183.
- [52] John W. Lamppa, Greg Horn, David Edwards, Toward the redesign of nutrition delivery, *Journal of Controlled Release*, Volume 190, 28 September 2014, Pages 201-209.
- [53] Lawrence A. Arogundade, Tai-Hua Mu, Fu-Ming Deng, Oluwaseyi K. Abegunde, Min-Jie Sun, Nutrition, gelation rheology and gel microstructure of isoelectric and ultrafiltered/diafiltered African yam bean (*Sphenostylis stenocarpa*) protein isolates, *LWT - Food Science and Technology*, Volume 59, Issue 2, Part 1, December 2014, Pages 1018-1024.
- [54] Mathieu Lihoreau, Jerome Buhl, Michael A. Charleston, Gregory A. Sword, David Raubenheimer, Stephen J. Simpson, Modelling nutrition across organizational levels: From individuals to superorganisms, *Journal of Insect Physiology*, Volume 69, October 2014, Pages 2-11.
- [55] Lorenzo M. Donini, Laura Maria Ricciardi, Barbara Neri, Andrea Lenzi, Giulio Marchesini, Risk of malnutrition (over and under-nutrition): Validation of the JaNuS screening tool, *Clinical Nutrition*, Volume 33, Issue 6, December 2014, Pages 1087-1094.
- [56] Nikitas N. Karanikolas, Knowledge and Information in Nutrition Software Design, *Procedia - Social and Behavioral Sciences*, Volume 147, 25 August 2014, Pages 398-404.
- [57] Susan L. Brantley, Mary K. Russell, Kris M. Mogensen, Jennifer A. Wooley, Elizabeth Bobo, Yimin Chen, Ainsley Malone, Susan Roberts, Michelle M. Romano, Beth Taylor, American Society for Parenteral and Enteral Nutrition and Academy of Nutrition and Dietetics: Revised 2014 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Nutrition Support, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 12, December 2014, Pages 2001-2008.e37.
- [58] Alecia J. Leonard, Kerry A. Chalmers, Clare E. Collins, Amanda J. Patterson, The effect of nutrition knowledge and dietary iron intake on iron status in young women, *Appetite*, Volume 81, 1 October 2014, Pages 225-231.
- [59] Anna R. Davies, Co-creating sustainable eating futures: Technology, ICT and citizen-consumer ambivalence, *Futures*, Volume 62, Part B, October 2014, Pages 181-193.
- [60] Krasimira Hristova, Ivy Shiue, Daniel Pella, R.B. Singh, Hilton Chaves, Tapan K. Basu, Lech Ozimek, S.S. Rastogi, Toru Takahashi, Douglas Wilson, Fabien DeMeester, Sukhinder Cheema, Manohar Garg, H.S. Buttar, Branislav Milovanovic, Adarsh Kumar, Svetoslav Handjiev, Germaine Cornelissen, Ivo Petrov, Prevention strategies for cardiovascular diseases and diabetes mellitus in developing countries: World Conference of Clinical Nutrition 2013, *Nutrition*, Volume 30, Issue 9, September 2014, Pages 1085-1089.
- [61] Beth N. Ogata, Dayle Hayes, Position of the Academy of Nutrition and Dietetics: Nutrition Guidance for Healthy Children Ages 2 to 11 Years, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 8, August 2014, Pages 1257-1276.
- [62] Debra Semans, Academy of Nutrition and Dietetics Registered Dietitian Brand Evaluation Research Results, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 10, October 2014, Pages 1640-1646.
- [63] Patricia Campos-Bedolla, Fruzsina R. Walter, Szilvia Veszella, Mária A. Deli, Role of the Blood-Brain Barrier in the Nutrition of the Central Nervous System, *Archives of Medical Research*, Volume 45, Issue 8, November 2014, Pages 610-638.
- [64] Silvia Berciano, José M. Ordovás, Nutrition and Cardiovascular Health, *Revista Española de Cardiología (English Edition)*, Volume 67, Issue 9, September 2014, Pages 738-747.
- [65] Robert J. Van Saun, Charles J. Sniffen, Transition Cow Nutrition and

Feeding Management for Disease Prevention, *Veterinary Clinics of North America: Food Animal Practice*, Volume 30, Issue 3, November 2014, Pages 689-719.

[66] Theodore H. Tulchinsky and Elena A. Varavikova, Chapter 15 - Health Technology, Quality, Law, and Ethics, In *The New Public Health* (Third Edition), edited by Theodore H. Tulchinsky/Elena A. Varavikova, Academic Press, San Diego, 2014, Pages 771-819.

[67] Ayoub Kasrati, Chaima Alaoui Jamali, Khalid Bekkouche, Hans Wohlmuth, David Leach, Abdelaziz Abbad, Plant growth, mineral nutrition and volatile oil composition of *Mentha suaveolens* subsp. *timija* (Briq.) Harley cultivated under salt stress conditions, *Industrial Crops and Products*, Volume 59, August 2014, Pages 80-84.

[68] Ruth Litchfield, Rose Martin, Jennifer Schultz, Iowa State Fair Food Finder iPhone Application, *Journal of Nutrition Education and Behavior*, Volume 47, Issue 2, March–April 2015, Pages 190-192.e1.

[69] John R.N. Taylor, Peter S. Belton, Trust Beta, Kwaku G. Duodu, Increasing the utilisation of sorghum, millets and pseudocereals: Developments in the science of their phenolic phytochemicals, biofortification and protein functionality, *Journal of Cereal Science*, Volume 59, Issue 3, May 2014, Pages 257-275.

[70] Christina M. Stark, Jamie Pope, Massive Open Online Courses: How Registered Dietitians Use MOOCs for Nutrition Education, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 8, August 2014, Pages 1147-1151,1153,1155.

[71] Tamar C. Weenen, Harry Commandeur, Eric Claassen, A critical look at medical nutrition terminology and definitions, *Trends in Food Science & Technology*, Volume 38, Issue 1, July 2014, Pages 34-46.

[72] Sebastian Vollmer, Kenneth Harttgen, Malavika A Subramanyam, Jocelyn Finlay, Stephan Klasen, S V Subramanian, Association between economic growth and early childhood nutrition – Authors' reply, *The Lancet Global Health*, Volume 2, Issue 9, September 2014, Pages e501-e502.

[73] Corrine I. Voils, Jennifer M. Gierisch, Maren K. Olsen, Matthew L. Maciejewski, Janet Grubber, Megan A. McVay, Jennifer L. Strauss, Jamiyla Bolton, Leslie Gaillard, Elizabeth Strawbridge, William S. Yancy Jr., Study design and protocol for a theory-based behavioral intervention focusing on maintenance of weight loss: The Maintenance After Initiation of Nutrition TrAINing (MAINTAIN) study, *Contemporary Clinical Trials*, Volume 39, Issue 1, September 2014, Pages 95-105.

[74] Sandra C. Van Calcar, Laurie E. Bernstein, Frances J. Rohr, Christine H. Scaman, Steven Yannicelli, Gerard T. Berry, A re-evaluation of life-long severe galactose restriction for the nutrition management of classic galactosemia, *Molecular Genetics and Metabolism*, Volume 112, Issue 3, July 2014, Pages 191-197.

[75] Inés M. Anchondo, Christina Campbell, Jamie Zoellner, Academy of Nutrition and Dietetics 2011 Survey on Member Research Activities, Needs, and Perceptions, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 5, May 2014, Pages 803-810.

[76] Anne Marie Davis, Sandra G. Affenito, Nutrition and Public Health: Preparing Registered Dietitian Nutritionists for Marketplace Demands, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 5, May 2014, Pages 695-699.

[77] Xingfeng Zhang, Xuehong Zhang, Bo Gao, Zhian Li, Hanping Xia, Haifang Li, Jian Li, Effect of cadmium on growth, photosynthesis, mineral nutrition and metal accumulation of an energy crop, king grass (*Pennisetum americanum* × *P. purpureum*), *Biomass and Bioenergy*, Volume 67, August 2014, Pages 179-187.

[78] Pamela S. Kent, Maureen P. McCarthy, Jerrilynn D. Burrowes, Linda McCann, Jessie Pavlinac, Catherine M. Goeddeke-Merickel, Karen Wiesen, Sarah Kruger, Laura Byham-Gray, Rory C. Pace, Valarie Hannahs, Debbie Benner, Academy of Nutrition and Dietetics and National Kidney Foundation: Revised 2014 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Nephrology Nutrition, *Journal of the Academy of Nutrition*

and Dietetics, Volume 114, Issue 9, September 2014, Pages 1448-1457.e45.

[79] Dianne M. Frazier, Courtney Allgeier, Caroline Homer, Barbara J. Marriage, Beth Ogata, Frances Rohr, Patricia L. Splett, Adrya Stemberge, Rani H. Singh, Nutrition management guideline for maple syrup urine disease: An evidence- and consensus-based approach, *Molecular Genetics and Metabolism*, Volume 112, Issue 3, July 2014, Pages 210-217.

[80] Allyson A. West, Marie A. Caudill, Applied Choline-Omics: Lessons from Human Metabolic Studies for the Integration of Genomics Research into Nutrition Practice, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 8, August 2014, Pages 1242-1250.

[81] Umesh Kapil, Madhulika Kabra, Neha Sareen, Preetika Khenduja, Shubhra Pande, Iodine nutrition status amongst neonates in Kangra district, Himachal Pradesh, *Journal of Trace Elements in Medicine and Biology*, Volume 28, Issue 3, July 2014, Pages 351-353.

[82] Xingfeng Zhang, Bo Gao, Hanping Xia, Effect of cadmium on growth, photosynthesis, mineral nutrition and metal accumulation of bana grass and vetiver grass, *Ecotoxicology and Environmental Safety*, Volume 106, August 2014, Pages 102-108.

[83] Jianhua Fan, Yanbin Cui, Yang Zhou, Minxi Wan, Weiliang Wang, Jingli Xie, Yuanguang Li, The effect of nutrition pattern alteration on *Chlorella pyrenoidosa* growth, lipid biosynthesis-related gene transcription, *Bioresource Technology*, Volume 164, July 2014, Pages 214-220.

[84] Whitney N. Ajje, Karen M. Chapman-Novakofski, Impact of Computer-Mediated, Obesity-Related Nutrition Education Interventions for Adolescents: A Systematic Review, *Journal of Adolescent Health*, Volume 54, Issue 6, June 2014, Pages 631-645.

[85] Dinamene Santos, Camila Batoreu, Luisa Mateus, A.P. Marreilha dos Santos, Michael Aschner, Manganese in human parenteral nutrition: Considerations for toxicity and biomonitoring, *NeuroToxicology*, Volume 43, July 2014, Pages 36-45.

[86] Marianne Shockley and Aaron T. Dossey, Chapter 18 - Insects for Human Consumption, In *Mass Production of Beneficial Organisms*, edited by Juan A. Morales-Ramos/M. Guadalupe Rojas/David I. Shapiro-Ilan, Academic Press, San Diego, 2014, Pages 617-652.

[87] Gretchen Vannice, Heather Rasmussen, Position of the Academy of Nutrition and Dietetics: Dietary Fatty Acids for Healthy Adults, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 1, January 2014, Pages 136-153.

[88] Patricia L. Steinmuller, Laura J. Kruskall, Christine A. Karpinski, Melinda M. Manore, Michele A. Macedonio, Nanna L. Meyer, Academy of Nutrition and Dietetics: Revised 2014 Standards of Practice and Standards of Professional Performance for Registered Dietitian Nutritionists (Competent, Proficient, and Expert) in Sports Nutrition and Dietetics, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 4, April 2014, Pages 631-641.e43.

[89] Kathryn M. Camp, Elaine Trujillo, Position of the Academy of Nutrition and Dietetics: Nutritional Genomics, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 2, February 2014, Pages 299-312.

[90] Brian Boyce, Nutrition Apps: Opportunities to Guide Patients and Grow Your Career, *Journal of the Academy of Nutrition and Dietetics*, Volume 114, Issue 1, January 2014, Pages 13-14,15.