

STUDY PROTOCOL

Open Access



# Prevalence in running events and running performance of endurance runners following a vegetarian or vegan diet compared to non-vegetarian endurance runners: the NURMI Study

Katharina Wirnitzer<sup>1</sup>, Tom Seyfart<sup>2</sup>, Claus Leitzmann<sup>3</sup>, Markus Keller<sup>4</sup>, Gerold Wirnitzer<sup>5</sup>, Christoph Lechleitner<sup>6</sup>, Christoph Alexander Rüst<sup>7</sup>, Thomas Rosemann<sup>7</sup> and Beat Knechtle<sup>8\*</sup>

## Abstract

**Background:** Beneficial and detrimental effects of various vegetarian and vegan diets on the health status are well known. Considering the growing background numbers of vegetarians and vegans, the number of vegetarian and vegan runners is likely to rise, too. Therefore, the Nutrition and Running High Mileage (NURMI) Study was designed as a comparative study to investigate the prevalence of omnivores, vegetarians, and vegans in running events and to detect potential differences in running performance comparing these three subgroups.

**Methods/design:** The NURMI Study will be conducted in three steps following a cross-sectional design. Step 1 will determine epidemiological aspects of endurance runners (any distance) using a short standardized questionnaire. Step 2 will investigate dietary habits and running history from eligible participants (capable of running a half-marathon at least) using an extended standardized questionnaire. Step 3 will collect data after a running event on finishing time and final ranking as well as a post-race rating of perceived exertion, mood status, nutrient and fluid intake during the race.

**Discussion:** Our study will provide a major contribution to overcome the lack of data on the prevalence and running performance of vegetarian and vegan runners in endurance running events. We estimate the prevalence of vegetarians and vegans participating in a running event to be less compared to the respective proportion of vegetarians and vegans to the general population. Furthermore we will validate the subject's self-assessment of their respective diet. This comparative study may identify possible effects of dietary behavior on running performance and may detect possible differences between the respective subgroups: omnivorous, vegetarian and vegan runners.

*Trial registration* Current controlled trials, ISRCTN73074080

**Keywords:** Diet, Nutrition, Running performance, Marathon, Endurance running, Vegetarian

## Background

The Academy of Nutrition and Dietetics (formerly the American Dietetic Association) publishes position papers

to vegetarian diets since 1980. The position paper of 2009 states that well-planned vegetarian diets, including total vegetarian or vegan diets, are appropriate for individuals during all stages of the lifecycle, including pregnancy, lactation, infancy, childhood, and adolescence, and for athletes (Craig and Mangels 2009).

The current position paper states that well-designed vegetarian diets, that may include fortified foods or

\*Correspondence: [beat.knechtle@hispeed.ch](mailto:beat.knechtle@hispeed.ch)

<sup>8</sup> Facharzt FMH für Allgemeinmedizin, Gesundheitszentrum St. Gallen, Vadianstrasse 26, 9001 St. Gallen, Switzerland

Full list of author information is available at the end of the article

supplements, meet current nutrient recommendations and are appropriate for all stages of the life cycle, including pregnancy, lactation, infancy, childhood, and adolescence (Cullum-Dugan and Pawlak 2015).

Numerous reputable studies (e.g. EPIC Oxford, Adventist health Study 1&2, and GEICO Study) described distinct advantages of vegetarian or vegan diets compared to diets containing meat and other foods of animal origin (Appleby et al. 1999; Davey et al. 2003; Le and Sabaté 2014; Mishra et al. 2013; Tonstad et al. 2013).

Health related benefits of vegetarian diets range from lower mortality from all-causes (Li 2014; Orlich et al. 2013) to lower body weight (BW), Body-Mass-Index (BMI) (Williams 1997), blood pressure (Yang et al. 2011), risk of obesity, and incidence of type 2 diabetes (Chiu et al. 2014; Zhang et al. 2010), as well as an enhanced antioxidant status capable of reducing exercise-induced oxidative stress (Kim et al. 2012; Trapp et al. 2010). Generally, the health of vegetarians is sound and compares favorably with that of the non-vegetarians (Appleby et al. 1999; Deriemaeker et al. 2011). As for all kinds of nutrition schemes, the health of vegans depends on their knowledge of how to compose and appropriately supplement their diet (Gilsing et al. 2010; Key et al. 2006; Le and Sabaté 2014; Obersby et al. 2013).

Since vegetarians consume widely divergent diets, a differentiation between various types of vegetarian diets is necessary. Many misunderstandings concerning vegetarianism are due to scientific data from studies without this differentiation. In the past, vegetarian or vegan diets have been described as being deficient in several nutrients including vitamin B<sub>12</sub> (Gilsing et al. 2010; Obersby et al. 2013) iron, zinc, calcium, omega-3 fatty acids and iodine (Key et al. 2006). Numerous studies have demonstrated that the observed deficiencies are usually due to poor meal planning (Leitzmann 2005).

Although there has been some concern about protein intake for vegetarian and vegan athletes, data indicate that all essential and non-essential amino acids can be supplied by plant food sources alone as long as a variety of foods are consumed and the energy intake is adequate (Nieman 1999). Furthermore well planned, varied, appropriately supplemented vegetarian and vegan diets high in nutrient density appear to successfully and effectively support parameters that influence athletic performance (Rodriguez et al. 2009), nutritional requirements, recovery and resistance to illness in athletes (Barr and Rideout 2004; Eisinger et al. 1994; Fuhrman and Ferreri 2010). Yet, some athletes, regardless of diet, may lack nutritional knowledge critical to preventing nutrition-related health problems. However, most athletes have positive attitudes toward nutrition and are receptive to nutritional counseling (Zawila et al. 2003).

Considering the growing background numbers of vegetarians and vegans (Stahler 2011; Vegetarierbund Deutschland 2015), we assume that the number counts of vegetarian and vegan runners is rising, too. Among Europeans, 5 % of the population are estimated vegetarian or vegan adding up to 37 million vegetarians and vegans overall (European Vegetarian Union 2015). Considering German speaking European countries (Austria, Germany, and Switzerland), 9 % of the Austrian population or 760,000 are estimated vegetarian and 80,000 vegan (Hnat 2015). In Germany 10 % of the population or 7.8 million are estimated vegetarian and 1.1 % or 900,000 vegan (Vegetarierbund Deutschland 2015). 5 % of the Swiss population is estimated vegetarian (Schweizerische Vereinigung für Vegetarismus 2015).

There are many vegetarian and vegan athletes especially in endurance and ultra-endurance disciplines such as Alan Murray and Janette Murray-Wakelin (marathon running) (Murray and Murray-Wakelin 2015), Michael Arnstein (marathon running) (Arnstein 2015), Fiona Oakes (marathon running), Vlad Ixel (ultra-marathon running), Scott Jurek (ultra-marathon running), Ruth Heidrich (triathlon) (Greatveganathletes.com 2015), Emil Voigt (Olympic track and field), Edwin Moses (Olympic track and field), Paavo Nurmi (Olympic track and field) (Finn 2015), Brendan Brazier (triathlon) (Brazier 2015), and Arnold Wiegand (ultra-triathlon) (Wiegand 2015).

Considering these and numerous other successful (ultra-) endurance athletes adhering to various vegetarian and vegan diets provides sufficient evidence that high-level endurance and ultra-endurance performance can be achieved by following a vegetarian or vegan diet. Therefore it is reasonable to conclude that a vegetarian or vegan diet is compatible with successful endurance and ultra-endurance performance. Yet the prevalence of vegetarians or vegans in endurance running events has not been investigated to date.

Scientific data about endurance and ultra-endurance athletes following a vegan diet is limited. Only two case reports describing vegan diet and athletic performance can actually be found in PubMed database (MEDLINE Database 2015). Wirnitzer and Kornexl (2014) described the successful implementation of a vegan diet during an 8-day mountain bike race of a female athlete. Leischik and Spelsberg (2014) investigated an ultra-endurance triathlete on a raw vegan diet, with reference to his ability to perform, cardiac status, and any symptoms of deficiency.

Since case reports are not adequate to draw any scientific conclusions to a larger population, the NURMI Study was designed as a comparative study with a large study population to investigate the prevalence in running events and to detect potential differences in running performance comparing three subgroups: omnivorous, vegetarian and vegan endurance runners.



ranking, finishing time, energy and fluid intake, in race dietary strategy, and physical and mental perception. The rate of perceived exertion (RPE, overall, leg muscles and respiratory system) will be assessed by using the Borg Scale (Borg 1998).

### **Subjects**

A large number of runners is planned to be enrolled in order to reach a sufficient number of subjects especially for Step 1. For Step 2 and 3 runners will need to meet the inclusion criteria. Runners participating in the NURMI Study will be recruited via advertisement by various channels such as directly at the websites of the organizers of marathon events, online running communities, and specific mailing-lists for runners, runners' magazines as well as magazines for health, vegetarian nutrition and lifestyle and personal communication. Additionally, information will also be provided by the official website ([www.nurmi-study.com](http://www.nurmi-study.com)). Core region are German-speaking countries of Europe (Germany, Austria, Switzerland).

### **Inclusion criteria**

For the epidemiological pre-study (Step 1) any subject active in running (any distance as well as any performance level) can participate. For successful participation in the main study (Step 2 and 3) a complete data set consisting of the following four items is required: written informed consent (1), at least 18 years of age (2), all NURMI questionnaires completed (3), successful participation in a running event of either half-marathon or marathon distance (4).

### **Description of measurements/methods/data collection**

#### **Questionnaires**

All questionnaires are standardized, based on self-report, and will be conducted as online-surveys. Subjects can access [www.nurmi-study.com](http://www.nurmi-study.com) and complete all questionnaires via encrypted interface.

#### **Further measurements**

Individual finishing time will be measured by the running events professional timing system and will be calculated as percentage of the overall winner's time.

#### **Voluntary physical examination (optional)**

Study participation does not involve any specific invasive type of intervention. Yet, we strongly advise the subjects to undergo a medical checkup including both a blood test and an incremental exercise test on a treadmill prior to the running event. Both can be conducted by a physician and analysed at a professional diagnostics laboratory at the runners hometown to determine critical micronutrient levels of iron, haemoglobin, serum

ferritin, haematocrit, magnesium, serum vitamin B<sub>12</sub>, holo transcobalamin, homocysteine and zinc, as well as to determine laboratory running performance. Participants will need to pay full cost for this voluntary laboratory testing, since it is optional. Subjects will be asked to measure body weight before and after the running event chosen for Step 3.

### **Outcomes**

#### **Primary outcomes**

In addition to running performance (individual marathon finishing time of Step 3) adjusted to performance level the primary outcome is the prevalence of kinds of diets (omnivorous, vegetarian, vegan) among runners attending running events.

#### **Secondary outcomes**

Outcomes from Step 1 are: nationality, sex, age, body weight, height, calculated BMI, kind of diet, attended races in past 2 years, finished running distances, personal best time on each distance, number of planned events for 2014/2015, in-race food and fluid consumption, daily/weekly training frequency, daily/weekly training load, period of preparation for main event, and aim of race participation.

Outcomes from Step 2 are: years of running experience, motivation for running then and now, assisted training, years of race experience, training intensity, medium/long-term goal of racing, additional specific kinds of training, specific diet including supplements, specific training/diet prior to race, diet on day of rest/training/race, pre/in/post-race diet, specific gear, relevant medical measures, and quality of life and health-related behavior.

Outcomes from Step 3 are: Pre-race: body weight (including clothing and shoes). In-race: individual finishing time, individual runtime as % of overall winners time (calculated), ranking, calculated pace, temperature, wind, air pressure, humidity, sunlight. Post-race: body weight (including clothing and shoes), calculated weight loss, RPE (Borg) whole body/respiratory/legs, mental mood, fluid and nutrient intake including breakfast, and dietary strategy during race.

### **Strengths of the study**

Since scientific data about endurance and ultra-endurance athletes following a vegan diet is limited the NURMI Study will be the first study to assess this issue considering a bigger sample size. The NURMI Study aims to provide a large data set comparing respective subgroups of omnivorous, vegetarian and vegan runners ranging from epidemiological aspects, dietary and training habits, in-race dietary consumption, and performance measurements. Large numbers of participants will allow to

discriminate between and, identify associations with, different dietary patterns and level of training status as well as to detect differences in running performance between subgroups of omnivores, vegetarians and vegans. To make sure to assess fit runners only the NURMI Study focuses on runners who are at least capable of coping the half-marathon distance as the primary inclusion criteria.

#### Limitations of the study

Not all vegetarians and vegans participating in running events may be within the reach of the various recruitment methods. Due to various season, daytime and location of races, environment conditions (e.g. weather including sun or rain, temperature, relative humidity) will vary among the respective running events. Furthermore, our study shares with others the limitation of the cross-sectional design; therefore the present investigation allows no conclusion regarding causality. Prospective cohort studies are needed to confirm the associations between specific kinds of diet, health status and endurance performance to assess the causal direction and to develop recommendations for nutritional intake for vegetarian and vegan runners for training and racing.

#### Statistical methods

Analyses will be performed using commercially available software (IBM SPSS Statistics 23, SPSS Inc., Chicago, IL, USA). All data derived from the statistical methods will be given in mean  $\pm$  standard deviation. Research shows that the most successful athletes in marathon and ultramarathon running events are frequently those who lose substantially more than 3–4 % BW during competition (Zouhal et al. 2011). Mean body weight of male recreational marathon runners is  $73.9 \pm 8.1$  kg (Barandun et al. 2012) and  $75.8 \pm 8.6$  kg (Friedrich et al. 2014) of male recreational half marathon runners. Mean body weight of female recreational runners is  $59.1 \pm 6.3$  kg (Rüst et al. 2013) and  $60.1 \pm 7.8$  kg (Friedrich et al. 2014) of female recreational half marathon runners. Expected body weight loss during a marathon race is  $2.3 \pm 2.2$  % overall (Zouhal et al. 2011). For male recreational marathon runners we expect a 2.3 % weight loss from 73.9 to 72.2 kg, therefore a sample size of 179 runners is needed to reach 80 % power with two-sided test and alpha of 0.05. For female recreational marathon runners we expect a 2.3 % weight loss from 59.1 to 57.7 kg, therefore a sample size of 159 runners is needed to reach 80 % power with two-sided test and alpha of 0.05. Since body weight loss during a marathon is inversely related to race finishing time (Zouhal et al. 2011) we expect the fastest runners to lose the most relative body weight during competition. Multivariate regression analyses will be used to determine

effects of kind of diet, sex, age, BMI, finished running distances, years of race experience, weekly training load, weekly training frequency, training intensity, in-race food and fluid consumption on individual finishing time (% of overall winners time, ranking, calculated pace). An analysis of variance will be performed to compare individual finishing time (% of overall winners time, ranking, calculated pace), sex, age, body weight, height, BMI, attended running events in past 2 years, finished running distances, personal best time on each distance, number of planned events for 2014/2015, daily/weekly training frequency, daily/weekly training load, period of preparation for main event, aim of race participation, years of running experience, motivation for running then and now, assisted training, years of race experience, training intensity, medium/long-term goal of racing, additional specific kinds of training, specific diet including supplements, specific training/diet prior to race, diet on day of rest/training/race, pre/in/post-race diet, in-race food and fluid consumption, specific gear, relevant medical measures, pre/post-race body weight (including clothing and shoes), calculated weight loss, in-race: nutritional strategy during race, fluid and nutrient intake including breakfast, mood status, and RPE (Borg) whole body/respiratory/legs, among the three subgroups created respective to diet.

#### Schedule of the study

Step 1 is accessible since October 1st 2014. Step 2 is accessible since February 1st 2015 and Step 3 is accessible since March 1st 2015. All questionnaires will be accessible through December 31st 2015. Analysis and interpretation will be taking place subsequently to the study.

#### Study centers

Data of all steps of the NURMI Study will be collected and analyzed in Austria. Core region are German-speaking countries of Europe (Germany, Austria, Switzerland).

#### Ethical principles

The study is conducted in accordance with medical professional codex and the Helsinki Declaration as of 1996 as well as Data Security Laws and good clinical practice guidelines. Study participation is voluntary and can be cancelled at any time without provision of reasons and without negative consequences.

#### The subject's written informed consent

Previous to study, subjects participating in the NURMI Study give written information about the content and extent of the planned procedure of the study. In case of study discontinuation, all data sets will be deleted.

**Vote of the ethics committee**

The study protocol was approved by the ethics board of St. Gallen, Switzerland on May 6, 2015 (EKSG 14/145).

**Duties on the part of the investigators**

The authors hereby confirm that ethical and scientific criteria as well as quality standards in terms of planning, study procedure, monitoring, analysis and documentation of the study will be fully observed and carried out in accordance with the protocol. All rights of the subjects will be respected and the results of the study will be handled correctly. The investigators are bound to conduct the study according to the study protocol and to report and document deviations to the ethics committee.

**Evaluation of the risk–benefit ratio**

All planned measurements are routine, justifiable and reasonable from a medical point of view. Study participation implicates no additional risk for the subject. Participation is voluntary and discontinuation will be possible at any time and without negative consequences. The study will be considered a contribution for endurance athletes, in particular endurance runners following some kind of vegetarian diet including the vegan diet. Moreover, the study aims to add knowledge to the currently very limited body of science considering the vegetarian but specifically the vegan endurance athlete. Furthermore the study could help to eliminate remaining concerns of coaches and runners and has the potential to show the adequacy of vegetarian and vegan diets on running performance as seen in professional runners.

**Benefits for the subjects**

Subjects will not be given any financial compensation. Subjects will receive a brief summary of the results of the NURMI Study if desired.

**Data security****IT-team**

All data are treated according to appropriate Federal Data Security Laws. The NURMI online surveys hosted on a dedicated virtual server, and run https-only, therefore all relevant data are transmitted SSL-encrypted. Access to the server as well as the file- and database-backups is restricted to the IT staff of the study team and the hosting provider (also a project partner). Security measurements include a local firewall on the server itself, regular security updates of the operating system and applications, no FTP access and no unencrypted access at all. SSH access is restricted to SSH key authentication, ruling out dictionary attacks, automatic detection of dictionary and other brute force attacks against SSH, with automatic locking of attacking clients' IP addresses, and

basic intrusion detection regarding operating system and applications. Gathered data will be stored pseudo-anonymised. Each subject will be assigned an identification code (ID), which will be kept in a separate database. Questionnaire data and subject's registration data will be stored in different databases. ID linkage will allow us to assign questionnaire data to each subject's data set. All members of the research staff are bound to their professional obligation to discretion. Data will be used and analyzed exclusively and only in the context of the NURMI Study.

**Trial status**

All questionnaires are open and will be accessible through December 31st 2015.

**Abbreviations**

NURMI: Nutrition and Running High Mileage; BW: body weight; BMI: body mass index; RPE: rate of perceived exertion; IT: information technology; ID: identification code.

**Authors' contributions**

KW: principal investigator, study coordinator, conception and design, financial support, statistics and analysis, data collection and analysis, manuscript writing, critical revision and final approval of the manuscript. TS: manuscript writing, critical revision and final approval of the manuscript. CL and MK: conception and design, critical revision and final approval of the manuscript. GW and ChL: IT. CR and TR: Statistical analysis. BK: conception and design, statistics and analysis, data collection and analysis, manuscript writing, critical revision and final approval of the manuscript. All authors read and approved the final manuscript.

**Author details**

<sup>1</sup> Pädagogische Hochschule Tirol, Pastorstraße 7, 6010 Innsbruck, Austria. <sup>2</sup> Medical Department, Ernst-Moritz-Arndt University of Greifswald, Fleischmannstraße 8, 17475 Greifswald, Germany. <sup>3</sup> Institute of Nutrition, University of Giessen, Wilhelmstr. 20, 35392 Giessen, Germany. <sup>4</sup> Institut für alternative und nachhaltige Ernährung, Am Lohacker 2, 35444 Biebertal/Giessen, Germany. <sup>5</sup> AdventureV & change2V, Berchat 302/2, 6135 Stans, Austria. <sup>6</sup> ITEG, Conradstraße 5, 6020 Innsbruck, Austria. <sup>7</sup> Institute of Primary Care, University of Zurich, Pestalozzistrasse 24, 8091 Zurich, Switzerland. <sup>8</sup> Facharzt FMH für Allgemeinmedizin, Gesundheitszentrum St. Gallen, Vadianstrasse 26, 9001 St. Gallen, Switzerland.

**Competing interests**

The authors declare that they have no competing interests.

Received: 17 August 2015 Accepted: 7 April 2016

Published online: 14 April 2016

**References**

- Appleby PN, Thorogood M, Mann JI, Key TJ (1999) The Oxford vegetarian study: an overview. *Am J Clin Nutr* 70(3 Suppl):525S–531S
- Arstein M (2015) Race stats. [www.thefruitarian.com/content/race-stats](http://www.thefruitarian.com/content/race-stats). Accessed 1 Aug 2015
- Barandun U, Knechtle B, Knechtle P, Klipstein A, Rust CA, Rosemann T, Lepers R (2012) Running speed during training and percent body fat predict race time in recreational male marathoners. *Open Access J Sports Med* 3:51–58
- Barr SI, Rideout CA (2004) Nutritional considerations for vegetarian athletes. *Nutrition* 20(7–8):696–703

- Borg (1998) The Borg RPE scale. In: Borg G (ed) Borg's perceived exertion and pain scales, chapter 5. Human Kinetics, Champaign, pp 29–38
- Braizer B (2015) Biography. [www.brendanbrazier.com/#!bio](http://www.brendanbrazier.com/#!bio). Accessed 1 Aug 2015
- Chiu TH, Huang HY, Chiu YF, Pan WH, Kao HY, Chiu JP, Lin MN, Lin CL (2014) Taiwanese vegetarians and omnivores: dietary composition, prevalence of diabetes and IFG. *PLoS ONE* 9(2):e88547
- Craig WJ, Mangels AR, American Dietetic Association (2009) Position of the American Dietetic Association: vegetarian diets. *J Am Diet Assoc* 109(7):1266–1282
- Cullum-Dugan D, Pawlak R (2015) Position of the academy of nutrition and dietetics: vegetarian diets. *J Am Diet Assoc* 115(5):801–810
- Davey GK, Spencer EA, Appleby PN, Allen NE, Knox KH, Key TJ (2003) EPIC-Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33 883 meat-eaters and 31 546 non meat-eaters in the UK. *Public Health Nutr* 6(3):259–269
- Deriemaeker P, Aerenhouts D, De Ridder D, Hebelinck M, Clarys P (2011) Health aspects, nutrition and physical characteristics in matched samples of institutionalized vegetarian and non-vegetarian elderly (> 65 yrs). *Nutr Metab (Lond)* 8(1):37
- Eisinger M, Plath M, Jung K, Leitzmann C (1994) Nutrient intake of endurance runners with ovo-lacto-vegetarian diet and regular western diet. *Z Ernährungswiss* 33(3):217–229
- European Vegetarian Union (2015) Wie viele Vegetarier? [www.euroveg.eu/lang/de/info/howmany.php](http://www.euroveg.eu/lang/de/info/howmany.php). Accessed 1 Aug 2015
- Finn (2015) Olympic vegetarians: the elite athletes who shun meat. *The Guardian*. [www.theguardian.com/lifeandstyle/wordofmouth/2012/jul/30/lizzie-arnitstead-vegetarian-athletes-olympics-2012](http://www.theguardian.com/lifeandstyle/wordofmouth/2012/jul/30/lizzie-arnitstead-vegetarian-athletes-olympics-2012). Accessed 1 Aug 2015
- Friedrich M, Rüst CA, Rosemann T, Knechtle P, Barandun U, Lepers R, Knechtle B (2014) A comparison of anthropometric and training characteristics between female and male half-marathoners and the relationship to race time. *Asian J Sports Med* 5:10–20
- Fuhrman J, Ferreri DM (2010) Fueling the vegetarian (vegan) athlete. *Curr Sports Med Rep* 9(4):233–241
- Gilting AM, Crowe FL, Lloyd-Wright Z, Sanders TA, Appleby PN, Allen NE, Key TJ (2010) Serum concentrations of vitamin B12 and folate in British male omnivores, vegetarians and vegans: results from a cross-sectional analysis of the EPIC-Oxford cohort study. *Eur J Clin Nutr* 64(9):933–939
- Greatveganathletes.com (2015) Runners, elite vegan runners. [www.greatveganathletes.com/runners](http://www.greatveganathletes.com/runners). Accessed 1 Aug 2015
- Hnat F (2015) Neueste IFES Studie bestätigt Veggie-Boom: 9% VegetarierInnen in Österreich! [www.ots.at/presseaussendung/OTS\\_20130821\\_OTS0142/neueste-ifes-studie-bestaetigt-veggie-boom-9-vegetarierinnen-in-oesterreich](http://www.ots.at/presseaussendung/OTS_20130821_OTS0142/neueste-ifes-studie-bestaetigt-veggie-boom-9-vegetarierinnen-in-oesterreich). Accessed 1 Aug 2015
- Key TJ, Appleby PN, Rosell MS (2006) Health effects of vegetarian and vegan diets. *Proc Nutr Soc* 65(1):35–41
- Kim MK, Cho SW, Park YK (2012) Long-term vegetarians have low oxidative stress, body fat, and cholesterol levels. *Nutr Res Pract* 6(2):155–161
- Le LT, Sabaté J (2014) Beyond meatless, the health effects of vegan diets: findings from the Adventist cohorts. *Nutrients* 6(6):2131–2147
- Leischik R, Spelsberg N (2014) Case report vegan triple-Ironman (raw vegetables/fruits). *Case Rep Cardiol* 2014:317246
- Leitzmann C (2005) Vegetarian diets: what are the advantages? *Forum Nutr* 57:147–156
- Li D (2014) Effect of the vegetarian diet on non-communicable diseases. *J Sci Food Agric* 94(2):169–173
- MEDLINE Database (2015) National Institutes of Health, US National Library of Medicine. [www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed). Accessed 1 Aug 2015
- Mishra S, Xu J, Agarwal U, Gonzales J, Levin S, Barnard ND (2013) A multicenter randomized controlled trial of a plant-based nutrition program to reduce body weight and cardiovascular risk in the corporate setting: the GEICO study. *Eur J Clin Nutr* 67(7):718–724
- Murray A, Murray-Wakelin J (2015) Running history. <http://rawveganpath.com/running-raw-around-australia/running-history>. Accessed 1 Aug 2015
- Nieman DC (1999) Physical fitness and vegetarian diets: is there a relation? *Am J Clin Nutr* 70(3 Suppl):570S–575S
- Obersby D, Chappell DC, Dunnett A, Tsiami AA (2013) Plasma total homocysteine status of vegetarians compared with omnivores: a systematic review and meta-analysis. *Br J Nutr* 109(5):785–794
- Orlich MJ, Singh PN, Sabaté J, Jaceldo-Siegl K, Fan J, Knutsen S, Beeson WL, Fraser GE (2013) Vegetarian dietary patterns and mortality in Adventist Health Study 2. *JAMA Intern Med* 173(13):1230–1238
- Rodriguez NR, Di Marco NM, Langley S (2009) American College of Sports Medicine position stand. Nutrition and athletic performance. *Med Sci Sports Exerc* 41:709–731
- Rüst CA, Knechtle B, Knechtle P, Rosemann T (2013) A comparison of anthropometric and training characteristics between recreational female marathoners and recreational female Ironman triathletes. *Chin J Physiol* 56(1):1–10
- Schweizerische Vereinigung für Vegetarismus (2015) Wie viele Vegetarier gibt es in der Schweiz? [www.vegetarismus.ch/heft/2001-1/anzahl.htm](http://www.vegetarismus.ch/heft/2001-1/anzahl.htm). Accessed 1 Aug 2015
- Stahler C (2011) How often do americans eat vegetarian meals? And how many adults in the US are vegan? The Vegetarian Resource Group (VRG) [www.vrg.org/journal/vj2011issue4/vj2011issue4poll.php](http://www.vrg.org/journal/vj2011issue4/vj2011issue4poll.php). Accessed 1 Aug 2015
- Tonstad S, Stewart K, Oda K, Batech M, Herring RP, Fraser GE (2013) Vegetarian diets and incidence of diabetes in the Adventist Health Study-2. *Nutr Metab Cardiovasc Dis* 23(4):292–299
- Trapp D, Knez W, Sinclair W (2010) Could a vegetarian diet reduce exercise-induced oxidative stress? A review of the literature. *J Sports Sci* 28(12):1261–1268
- Vegetarierbund Deutschland (2015) [www.vebu.de/lifestyle/anzahl-der-vegetarierinnen](http://www.vebu.de/lifestyle/anzahl-der-vegetarierinnen). Accessed 1 Aug 2015
- Wiegand A (2015) Vegane Ernährung und Ausdauersport. [www.vegan-sports.de](http://www.vegan-sports.de). Accessed 1 Aug 2015
- Williams PT (1997) Interactive effects of exercise, alcohol, and vegetarian diet on coronary artery disease risk factors in 9242 runners: the National Runners' Health Study. *Am J Clin Nutr* 66(5):1197–1206
- Wirnitzer KC, Kornel E (2014) Energy and macronutrient intake of a female vegan cyclist during an 8-day mountain bike stage race. *Proc (Bayl Univ Med Cent)* 27(1):42–45
- Yang SY, Zhang HJ, Sun SY, Wang LY, Yan B, Liu CQ, Zhang W, Li XJ (2011) Relationship of carotid intima-media thickness and duration of vegetarian diet in Chinese male vegetarians. *Nutr Metab (Lond)* 8(1):63
- Zawila LG, Steib CS, Hoogenboom B (2003) The female collegiate cross-country runner: nutritional knowledge and attitudes. *J Athl Train* 38(1):67–74
- Zhang L, Qin LQ, Liu AP, Wang PY (2010) Prevalence of risk factors for cardiovascular disease and their associations with diet and physical activity in suburban Beijing, China. *J Epidemiol* 20(3):237–243
- Zouhal H, Groussard C, Minter G, Vincent S, Cretual A, Gratas-Delamarche A, Delamarche P, Noakes TD (2011) Inverse relationship between percentage body weight change and finishing time in 643 forty-two-kilometre marathon runners. *Br J Sports Med* 45(14):1101–1105

**Submit your manuscript to a SpringerOpen® journal and benefit from:**

- Convenient online submission
- Rigorous peer review
- Immediate publication on acceptance
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](http://springeropen.com)