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Article *in* Annals of Nutrition and Metabolism · February 1999

DOI: 10.1159/000012770 · Source: PubMed

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Original Paper

Annals of Nutrition & Metabolism

Ann Nutr Metab 1999;43:69–79

Received: April 17, 1998
Accepted: January 15, 1999

Consequences of a Long-Term Raw Food Diet on Body Weight and Menstruation: Results of a Questionnaire Survey

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Key Words

Raw food diet · Nutritional deficiency · Body mass index · Weight loss · Underweight · Chronic energy deficiency · Amenorrhea

Abstract

Objective: To examine the relationship between the strictness of long-term raw food diets and body weight loss, underweight and amenorrhea. ***Methods:*** In a cross-sectional study 216 men and 297 women consuming long-term raw food diets (3.7 years; SE 0.25) of different intensities completed a specially developed questionnaire. Participants were divided into 5 groups according to the amount of raw food in their diet (70–79, 80–89, 90–94, 95–99 and 100%). A multiple linear regression model (n = 513) was used to evaluate the relationship between body weight and the amount of raw food consumed. Odds of underweight were determined by a multinomial logit model. ***Results:*** From the beginning of the dietary regimen an average weight loss of 9.9 kg (SE 0.4) for men and 12 kg (SE 0.6) for women was observed. Body mass index (BMI) was below the normal weight range (< 18.5 kg/m^2) in 14.7% of male and 25.0% of female subjects and was negatively related to the amount of raw food consumed and the duration of the raw food diet. About 30% of the women under 45 years of age had partial to complete amenorrhea; subjects eating high amounts of raw food (> 90%) were affected more frequently than moderate raw food dieters. ***Conclusions:*** The consumption of a raw food diet is associated with a high loss of body weight. Since many raw food dieters exhibited underweight and amenorrhea, a very strict raw food diet cannot be recommended on a long-term basis.

Introduction

Raw food diets are mainly vegetarian diet forms based on the experience of physicians who were highly engaged in healthful nutrition, such as Bircher-Benner, Waerland and Shel-

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Table 1. Definition of raw food diets

Raw food diets consist predominantly or exclusively of unheated foods, mainly of plant origin (partly also of animal origin).
Some foods are included that require a certain degree of heating for their production (e.g. cold-pressed honey and cold-pressed oils) as well as foods that require a certain amount of heat during their processing (e.g. dried fruits, dried meat and fish, certain nuts).
Furthermore, cold-smoked produce (e.g. meat and fish) as well as pickled or fermented vegetables can be included in the raw food diet [20, 36].

ton, whose writings constitute the origins of the main raw food diet streams. Today raw food diets are influenced mainly by the Diamonds and are quite varied forms of nutrition, consisting mostly of natural foods prepared in unheated, non-mixed meals [1–6]. Staple foods like meat, dairy products, cereals and cereal products are largely avoided. Therefore, fruits and vegetables make up a high percentage of the food consumed and have to meet body energy needs. A study of the literature shows that raw food diets are subdivided into vegetarian and non-vegetarian forms.

One of the extreme forms of raw food diets is instinctotherapy. Its founder, Guy-Claude Burger [3], recommends eating a.o. non-heated meat. A few other authors suggest the consumption of only small amounts of cooked meat. Because of the large amounts of fruits, the raw food diet according to Wandmaker [5] is viewed as unbalanced and is therefore not recommended by the German Nutrition Society [7]. The definition of raw food diets according to the Giessen Raw Food Working Group is an attempt to develop a basis for comparison of data reported in the literature (table 1).

The main reasons for practising a raw food diet as stated by its followers are to attain health, to prevent illness and to live in a natural and healthy way for a long time [8, 9]. Some medical reports suggest a raw food diet as therapy for diseases such as allergies, hypertension and overweight [1, 10–12]. Raw food diets are mostly considered to be a long-term form of nutrition. However, the Diamonds suggest that their raw food diet can additionally decrease body weight [2–5, 8].

Almost all persons experience drastic changes in body weight after starting to consume a raw food diet. The weight loss can be substantial and often leads to a very low body weight [8, 9, 13]. Underweight and nutritional deficiencies in females are related to amenorrhea, low bone density and osteoporosis [14–18]. The aim of the reported study was to examine the association between the strictness of a raw food diet and body weight loss, underweight and amenorrhea.

Methods

Subjects

Following announcements in several German health magazines (October 1992 to January 1993), 1,328 persons classifying themselves as raw food dieters were assessed using a short questionnaire sent by mail. Of those, 865 persons estimated the amount of raw food in their diet to be more than 70%. This amount corresponds to the minimum amount of raw food recommended by several authors [6]. A specially developed questionnaire was sent to these selected persons, of whom 88% responded. Individuals practising a raw food diet for <4 months or being <16 years of age or not living in Germany, and who had participated in the pre-test of the questionnaire were excluded from the study. After this selection 572 persons remained in the study. Complete data sets were evaluated of 513 persons (216 men and 297 women).

For statistical analyses, participants were divided into 5 groups according to the amount of raw food in their diet. The cutoff points were 70, 80, 90, 95, and 100% of raw food. The diet groups were classified as meat eaters (n = 253), vegetarians (n = 184) and vegans (n = 135). Vegetarians omit meat and fish, and vegans additionally avoid dairy products and eggs from their diet.

Table 2. Determinants of BMI: multiple linear regression coefficients ordered according to descending β ($p < 0.0001$, adjusted $R^2 = 0.572$)

Independent determinants	β	Significance
BMI before a raw food diet	0.723	0.000
Amount of raw food consumed, %	–0.144	0.000
Duration of raw food diet	0.075	0.016
Vegan diet group	–0.068	0.030
Gender	0.053	0.080
Age	–0.019	0.566
Total food intake, g	0.006	0.834

Instruments

A short questionnaire was developed as a selection instrument. It contained a limited number of questions concerning the amount of raw food consumed and the duration of the raw food diet. To control the validity of the self-estimated amounts of raw food consumed, the results were compared to the computed amounts of a food frequency questionnaire (FFQ) described below. There was a high correspondence between the amounts of raw food consumed [8].

The main questionnaire focused on the nutrition behavior and the health situation of individuals consuming a raw food diet. Body weight data and weight development were assessed retrospectively. The concept was based on discussions with several authors of books on raw food diets and interviews of raw food dieters and their self-help groups. Comprehension of the questionnaire was tested with a random sample of 16 raw food dieters drawn from the selected participants that were then excluded from further participation. Questions which were considered misleading or unclear were not included in the final instrument.

The amounts of raw food consumed were assessed by the FFQ developed by Aalderink et al. [19], Hoffmann [20] and Hoffmann et al. [21] and employed in the Giessen Wholesome Nutrition Study. Its validity as an instrument of selection was tested for bias by Hoffmann [20]. The semiquantitative FFQ consisted of 80 items modified for special demands of raw food diets. The amount of raw food was calculated by the raw/cooked weight ratio.

Statistics

All statistical calculations were performed with the statistical software package SPSS 8.0. The results are presented as means with the standard error of mean (± SE). Mean body mass index (BMI) values (weight (kg)/height $(m)^2$) were calculated separately for females and males after adjusting for age at recruitment. The BMI classification according to Ferro-Luzzi et al. [15] was employed (table 2). A multiple linear regression model for BMI as a dependent factor considers age, gender, BMI before starting a raw food diet, duration of the raw food diet, diet group and total food intake. Odds ratios of underweight were computed by a multinomial logit model considering gender and amount of raw food consumed. Therefore, participants were divided into 5 groups eating different amounts of raw food: 70–79, 80–89, 90–94, 95–99 and 100%. In the regression and the logit models of body weight data only persons with complete data sets were included (n = 513). Calculations on amenorrhea were carried out with data from non-pregnant and non-menopausal women <45 years of age (n = 145). Odds ratios of amenorrhea were calculated by a multinomial logit model considering the amount of raw food consumed. To test the fit the loglinear models were compared to different models including several factors and several divisions of the amount of raw food consumed. Only small differences in parameter estimates were observed [22].

Results

General Health Behavior and Diseases

Most of the raw food dieters investigated in this study consumed high amounts of raw food (> 90%; fig. 1). The mean percentage of raw food eaten was 91 ± 0.4%, and the average duration of a raw food diet was 3.7 ± 0.25 years. There were only a few participants who smoked (2.1%); the raw food dieters consumed only small amounts of alcoholic beverages (beer 13 ± 2.6 ml/day; wine 9 ± 2.0 ml/

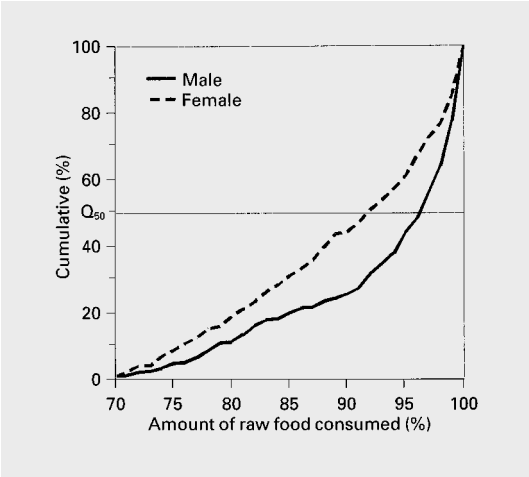

Fig. 1. Cumulative frequency distribution of amount of raw food consumed in male (n = 230) and female (n = 342) raw food dieters.

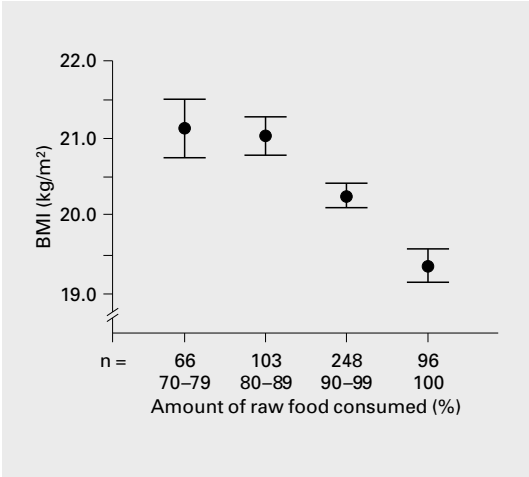

Fig. 2. Error bars of age-adjusted mean BMI ± SE divided into groups according to the amount of raw food consumed.

Table 3. Fasting periods of investigated raw food dieters

	%
Regular fasting (n = 282)	49.3
Fasting period, days	
1	29.8
2–4	27.7
5–7	23.8
8–14	12.4
Several weeks	6.4

day; spirits 0.1 ± 0.0 ml/day) and most of them (89%) participated in various kinds of physical activities.

Only a few participants (7%) used mineral or vitamin supplements, 7.9% consumed algae products, and 0.6% of the 342 female participants took oral contraceptives. Enemas were regularly applied by 16.1% of raw food dieters, about 25% of them more than once a week. About half of the participants (n = 282) fasted at least once a year. Total fasting (48.7%) and juice fasting (39.2%) were preferred. The main reason for fasting was purification (58%). The fasting periods lasted from 1 day to several weeks (table 3).

Most of the participants changed to a raw food diet for health reasons; other reasons did not play an important role (<10%). About 55% changed to a raw food diet because of their own disease, and 17% because of a disease of a family member. The most important disorders were diseases of the gut, allergies, asthma and rheumatism. About 94% of these participants believed to be closer to recovery from their disease since change of diet. Most participants (98%) were very content with their raw food diet.

Body Weight Reduction and Amount of Raw Food Consumed

The age-adjusted mean BMI of male participants was 20.7 ± 0.2 kg/m^2 and of female participants was 20.1 ± 0.1 kg/m^2. The BMI range showed a tight distribution (95% CI 20.2–20.6 kg/m^2). Most participants (73.8%)

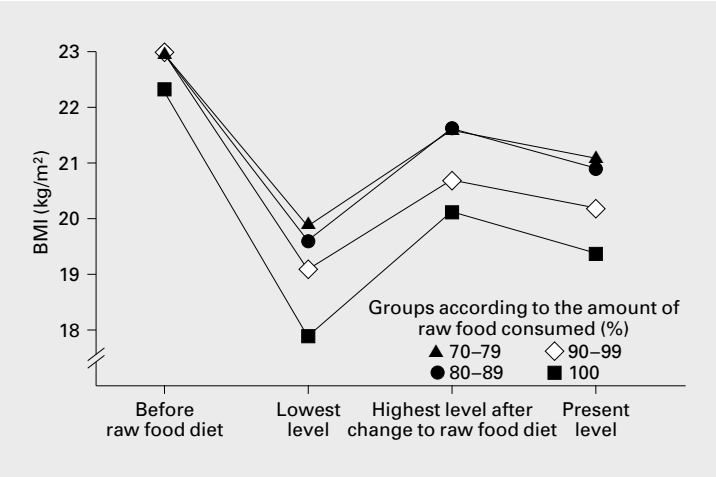

Fig. 3. Age-adjusted mean BMI before and during the consumption of raw food diets.

Table 4. Classification of BMI and distribution of relative body weight in relation to gender and amount of raw food consumed (%)

Classification by Ferro-Luzzi [15]	BMI kg/m²	Raw food dieters					
		male	female	70–79%	80–89%	90–99%	100%
Severe underweight (CED grade III)	<16	0.4	1.5	1.3	0.8	0.8	1.9
Moderate underweight (CED grade II)	16.0–16.9	2.2	4.1	2.5	0.8	3.4	6.8
Mild underweight (CED grade I)	17.0–18.4	12.1	19.3	11.4	11.9	17.8	22.3
Normal weight	18.5–24.9	78.3	69.6	69.6	79.4	73.5	67.0
Overweight	25.0–29.9	6.1	3.8	12.7	4.0	4.2	1.0
Obesity	30.0–39.9	0.0	1.2	2.5	0.8	0.4	0.0
Severe obesity	≥40.0	0.0	0.0	0.0	0.0	0.0	0.0
Missing data		0.9	0.6	0.0	2.4	0.0	1.0
n		230	342	79	126	264	103

had a normal body weight; 6.3% of the men and 4.8% of the women were overweight; 1.2% of the women and none of the men were obese. Unexpectedly 14.7% of the men and 25.0% of the women were underweight. Of these, 2.6% of the men and 5.7% of the women suffered from chronic energy deficiency (CED) grade II or III (table 4). Participants eating a strict raw food diet showed a lower BMI than persons consuming a moderate raw food diet (fig. 2). Most raw food dieters experienced a dramatic loss of body weight after changing to a raw food diet. Body weight stabilized after some time and settled at a level below the initial weight (fig. 3). The mean loss of body weight from the time of changing to a raw food diet to the time of evaluation was 9.9 ± 0.4 kg (95% CI 4–20 kg) for male (n = 216) and 12 ± 0.6 kg (95% CI 3–26 kg) for female (n = 297) participants. There were substantial

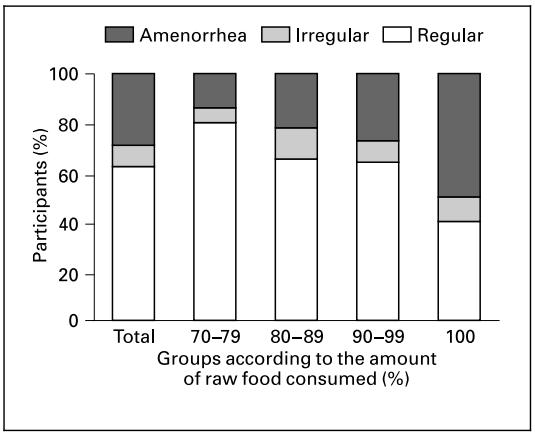

Fig. 4. Classification of menstruation occurrence in groups according to the amount of raw food consumed (n = 145).

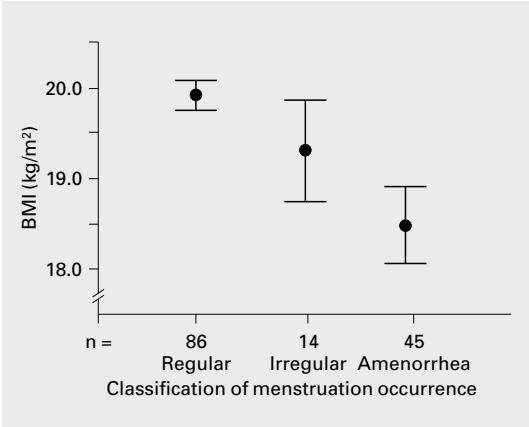

Fig. 5. Error bars of mean BMI ± SE in relation to classification of menstruation occurrence (n = 145).

differences between groups according to the amount of raw food consumed and loss of body weight (fig. 3).

The multiple linear regression model ($p < 0.0001$, adjusted $R^2 = 0.572$) showed that low body weight had a strong linear relation (monotonic decrease) to the amount of raw food eaten (table 2). The BMI was negatively affected in the vegan group, but was unaffected by the total food intake. The relations to gender and duration of raw food diet consumption were statistically significant. Females showed a lower BMI than males, and the BMI increased slowly with the duration of raw food diet consumption. Odds of becoming underweight calculated by a multinomial logit model (table 5) were 3 times higher for strict raw food dieters (100% raw food) and 2 times higher for rather strict raw food dieters (95–99% raw food) than for moderate raw food dieters (<80% raw food). By including the diet group in the logit model, no statistically significant effects were observed. Vegans had no significantly higher odds of underweight than vegetarians or meat eaters.

Amenorrhea as a Functional Problem of Female Raw Food Dieters

The mean age of non-pregnant and non-menopausal women under 45 years of age was 32.9 ± 0.63 years. Menstruation was stated as being regular in about 60% of the valid answers. The intensity of menstruation was estimated as strong to very strong by 9.1%, as medium by 53.3% and as weak to very weak by 37.7% of the women. Approximately 10% had irregular menstruation and 30% claimed to have no or rare menstruation. About 70% of female participants noticed a change in menstruation since changing their diet. Of the female raw food dieters of childbearing age, 23% suffered from a total absence of menstruation. Female participants were divided into 3 groups: periodical (n = 87) , irregular (n = 14), and absence of menstruation (n = 44). The groups show statistically significant differences in the amounts of raw food consumed ($p = 0.008$) and in BMI ($p = 0.000$) but not in age. Women with partial to total amenorrhea ate more raw food and had a lower BMI than the other women (fig. 4, 5).

Table 5. Parameter estimates of the multinomial logit model of becoming underweight, goodness-of-fit statistics and measures of association (reference group: 70–79% amount of raw food)

Factor	Odds ratio[1]	Estimate[1]	SE	z value[2]	Asymptotic 95% CI	
					lower	upper
Underweight	0.1	**–2.3329**	0.3670	–6.36	–3.05	–1.61
Gender female	2.3	**0.8481**	0.2331	3.64	0.39	1.31
Raw food consumed						
100%	3.0	**1.0923**	0.3872	2.82	0.33	1.85
95–99%	2.0	**0.7016**	0.3632	1.96	–0.01	1.41
90–94%	1.2	0.1762	0.4413	0.40	–0.69	1.04
80–89%	0.8	–0.1832	0.4114	–0.45	–0.99	0.62

Goodness-of-fit statistics (likelihood ratio) significance = 0.7686.
Measures of association: entropy = 0.0586, concentration = 0.0626.
1 Odds ratio = $e^{estimate}$.
2 Values statistically significantly different from zero (α = 5%) are given in bold (z value $\geq$ 1.96).

Table 6. Parameter estimates of the multinomial logit model of having amenorrhea, goodness-of-fit statistics and measures of association (reference group: 70–79% amount of raw food)

Factor	Odds ratio[1]	Estimate	SE	z value[2]	Asymptotic 95% CI	
					lower	upper
Amenorrhea	0.2	–1.8718	0.7596	–2.46	–3.36	–0.38
Raw food consumed						
100%	7.0	**1.9408**	0.8456	2.30	0.28	3.60
95–99%	2.6	1.0833	0.8209	1.32	–0.53	2.69
90–94%	2.0	0.7087	0.9162	0.77	–1.09	2.50
80–89%	1.8	0.5988	0.8717	0.69	–1.11	2.31

Goodness-of-fit statistics were not calculated due to model saturation.
Measures of association: entropy = 0.0547, concentration = 0.0680.
1 Odds ratio = $e^{estimate}$.
2 Values statistically significantly different from zero (α = 5%) are given in bold (z value $\geq$ 1.96).

Odds of having amenorrhea calculated by a multinomial logit model (table 6) were 7 times higher for strict raw food dieters (100% raw food) than for moderate raw food dieters (<80% raw food). Inclusion of the diet group in the logit model showed no statistically significant relationship between odds of amenorrhea and diet group. There were no higher odds for vegans than for vegetarians or meat eaters.

Discussion

The consumers of raw food diets view their eating behavior as part of a wholesome lifestyle concept, including an overall healthy way of life which means more than just an alternative diet. Adherents of raw food diets usually lead a healthy life, i.e. they are physically active, drink little alcohol and do not smoke. This lifestyle shows a preventative effect against diseases related to nutrition and lifestyle [23, 24]. At present, little is known about the consequences of a raw food diet on long-term health.

Fasting periods and regular enemas are often recommended by proponents of raw food diets as a method of body cleansing [6, 8, 9, 25]. About half of the participating raw food dieters fasted at least once a year, some of them for several weeks. It is reported that very long fasting periods (>100 days) can result in morphological changes in the cardiac muscle with ECG changes caused by protein deficiency [26]. Even though none of the participants of the Giessen Raw Food Study fasted for such a long period of time, fasting for them could have been a risk because of their low energy stores and low body weight, particularly in association with their low energy diet.

Most proponents of raw food diets recommend this dietary regimen as a long-term diet. Only the Diamonds advocate their raw food diet also as a therapy for weight loss [2–5, 8, 25]. The results of the Giessen Raw Food Study show a substantial reduction in body weight for participants during long-term consumption of a raw food diet. The body weight first decreases and then usually increases to a level below the initial weight. The very consequent raw food dieters show a greater loss of body weight than the moderate raw food dieters. Change in body weight usually indicates a change in energy balance and reflects changes in energy stores and in active body tissues [27]. Decreasing body weight and concomitant undernutrition result in a greater visceral mass to muscle mass ratio [28].

The BMI reflects body energy stores and is used as an indicator for CED [29–32] since it shows a strong correlation with body fat [27, 33]. Most participants of the Giessen Raw Food Study had BMI values within the normal range; however, 25% of the females and 14.7% of the males were below the normal range – in some cases a BMI reflecting CED was observed. Undernutrition affects only a small group of the average German population – 5.6% of the females and 3.8% of the males, mostly under the age of 34 years, are underweight [34]. The optimum range of BMI which is compatible with good health is 20.1–25.0 kg/m^2 for males and 18.7–23.8 kg/m^2 for females [15, 27]. Low body weight is often reported for vegetarians and vegans [35], but a BMI reflecting CED is rarely observed in contrast to raw food dieters. The main reason for a low BMI for raw food dieters is the consumption of a strict raw food diet. Furthermore, BMI is correlated with the duration of the raw food diet and the vegan regimen.

Appleby et al. [36] observed a negative association between BMI and carbohydrate intake and the intake of dietary fiber in low meat eaters. Raw food dieters eat mainly fruits and vegetables. They mostly omit dairy products, meat, cereals and cereal products and therefore, their diet contains high amounts of dietary fiber and carbohydrates. Additionally, an insufficient energy supply in 43% of raw food dieters was reported [13, 37]. Very strict raw food dieters have higher odds of becoming underweight than moderate raw food dieters. Therefore, a very strict raw food diet has to be considered as a risk to health if practised for a long time.

A high percentage of the women (70%) participating in the Giessen Raw Food Study had

irregularities in their menstruation after changing to a raw food diet. A total absence of menstruation was observed in 23% of female raw food dieters of childbearing age. With increasing amounts of raw food the BMI decreased and the odds of having amenorrhea increased. The participants judged this as a success of their diet, since proponents of raw food diets view menstruation as a process of cleansing. They claim that eating enough raw food stops menstruation so that the cleansing process is no longer required [3, 5, 38]. This attitude concerning amenorrhea has no scientific basis and ignores the possibility that amenorrhea may lead to impaired health.

Nutritional deficiencies, low body fat stores, CED and low body weight which is related to changes in body composition are associated with amenorrhea [14, 27, 39–41]. Amenorrhea is also observed with eating disorders like bulimia and anorexia [17, 41–43]. Professional sportswomen often show disordered eating habits, amenorrhea, and osteoporosis. This is collectively known as the female athlete triad [44]. An imbalance between energy intake and energy expenditure leads to an energy deficit which is associated with menstrual irregularities and reproductive dysfunction in female long distance runners [45].

A low BMI is indicative for CED and is associated with amenorrhea. Amenorrhea can result in impaired fertility [16, 27, 42]. When estrogen levels are low, changes in mineral, glucose and fat metabolism accompany amenorrhea. These metabolic changes affect bone and cardiovascular health, increasing the risk of osteoporosis and coronary heart disease in later life [16, 42]. The maternal BMI is related to the birth weight of a child [46]. Mothers from China, India, Ethiopia and Zimbabwe with a low BMI have babies with low birth weights [23, 27]. In the female raw food dieters of this study the odds of having amenorrhea increased with the strictness of the raw food diet. For women of childbearing age there may be further consequences for the unborn child in case of pregnancy.

The absence of obesity in raw food dieters should be seen positively, but their extremely low body weight may be a problem. While an energy restriction for many adults consuming an average Western diet is recommended, a strict raw food diet cannot guarantee an adequate energy supply [20, 37]. A low BMI in raw food dieters indicates low body energy stores and CED. In a mostly vegan diet like the raw food diets with low protein and energy intake, protein metabolism can be affected to the point of protein energy malnutrition. The incidence of amenorrhea in female raw food dieters is also a sign for functional problems in the long-term consumption of a raw food diet. As shown in this study the main determinant for the BMI and the incidence of amenorrhea is the amount of raw food in the diet. On the basis of the data obtained and the reports in the literature, a strict raw food diet with amounts of raw food over 90% cannot be recommended. Studies yet to be published with diets containing liberal amounts of raw food indicate that about half the food eaten in an uncooked form may be optimal for health under normal conditions.

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