Effects of a diet from biodynamic production on human immunologic parameters and personally experienced well-being; a pilot study in a convent.

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Short title

Effects of biodynamic food in humans

Abstract

A pilot study was conducted in a convent to assess the impact of biodynamic diet on immunology and personally experienced well-being of humans. 32 probands were provided with conventional prefrozen ready-made, conventional freshly prepared, and freshly prepared biodynamic food. Blood and stool samples were taken and psychological questionnaires were applied. The primary effects on immunological parameters were correlated with the

conversion from ready-made to freshly prepared meals. During the biodynamic periods systolic blood pressure was lowered whereas personally experienced well-being was improved. The study was not blinded hence the methodological approach and its limitations are discussed.

Key words

Organic food; biodynamic food; nutrition, immune status; well-being

Introduction

In the recent years, a number of reviews on the nutritional value of organic food on human health appeared (Woese et al., 1997, Williams, 2002, Bourn et al., 2002, Magkos et al., 2003, Biao et al., 2003), which all reported relatively low evidence for a better nutritional value of organically compared to conventionally produced food. This seems to be in opposite to the fact that a growing group of consumers is willing to pay the prices for organically grown products, because they expect these products to enhance health and overall well-being (Yiridoe et al., 2005). The indifferent results of the reviews are astonishing, because in many single studies, an advantage of organic food is repeatedly proven on the level of single functional molecules such as antioxidants and minerals in fruits and crops (Worthington, 2001, Carbonaro et al., 2002, Caris-Veyrat et al., 2004) or polyunsaturated fatty acids in milk and meat products (Kraft et al., 2003, Bergamo et al., 2003, Leiber et al., 2005; Razminowicz et al., 2006). However, the view on concentrations of single functional molecules is more likely a “snapshot” (Cole et al., 2004), and does not reflect the complexity of interactions and bioavailability (Bourn et al., 2002, Magkos et al., 2003). Even a high content of any single Vitamin is not necessarily a nutritional advantage (Lichtenstein et al., 2005) since for instance the antioxidants act in a complex equilibrium of many substances, which would have to be

maintained to achieve a food, which earns the label “healthy”. Also from a medical viewpoint it is recommended to shift the emphasis from single nutrients towards the total diet (Lichtenstein et al., 2005). Further, the term “health” may not be defined only in function of physiological traits, but also in psychic and mental well-being, which is affected not only by the ingredients of a food.

The organic food chain comprises several levels of complexity, and a proof and generalizing evaluation of the health value of organic food would have to integrate all these levels, beginning from the very various agricultural circumstances, coming to manufacturing, distribution and sociological circumstances of consumption (Bourn et al., 2002, Magkos et al., 2003, Yiridoe et al., 2005, Cole et al., 2004). Although some authors claim nearly all past studies to fail in this task (Magkos et al., 2003) it is still unclear how it should be realized. Any focus, be it on the agricultural level (e.g. fertilizing trials), or be it on the nutritional level (single products or substances) fails necessarily in describing the complex system and integrating the multifarious different possibilities, the organic food chain comprises. Certainly, more studies, involving human probands are required to be carried out (Woese et al., 1997, Magkos et al., 2003) to evaluate the direct effect of organic foods. However, such studies are a certain methodological challenge. Firstly, it remains a question, whether single products, such as organic milk should be investigated, or a total organic diet. The former approach would fail in elucidating the question of the general organic diet, the latter approach would be unable to answer, which compounds and substances exactly are involved in possible effects of organic food consumption. Secondly, the design of the study comprises difficulties. A double-blind study seems to allow to isolate true physiological effects, but it would not include the psychological components the consumption of organic food certainly has (Köpke, 2005). If in society there are motivation or expectance effects of organic diet (Bourn et al., 2002), they perform a certain reality and have to be included in the evaluations. Furthermore,

a number of limitations of double-blind designs are shown (Kiene, 1996). These designs may e.g. cause a counter-intuitive psychotropic response (Kirsch et al., 1988), which may severely bias even physiological reactions. Application of other than only blinded studies is required and methods are suggested for the alternative medicine (Kiene et al., 1998). Since organic agriculture claims a holistic approach to nature and nutrition, similar to alternative medicine, it may seem worthwhile to search for similar research methods, at least for a share of the investigations done in this field.

It seems hard to believe, that the open questions once will be answered by „the“ one and perfect study. Rather, different approaches are required to elucidate the problem of organic nutrition from multifarious perspectives. This would also provide the challenge and the possibility to bring the discussion about the value of and the need for holistic and reductionistic research approaches (Lockeretz, 2000) down to the basis of a realized scientific practice. Then, hopefully, „the“ one and perfect review might appear.

In the present study, an attempt for holistic research in organic nutrition was made. This means, that the influence of a certain diet on different spheres of the human being was investigated, including psychic and mental effects. This aim could only be reached with a non blinded study. Thus, the present study included psychotropic aspects of the expectations and empathy towards a certain diet. This was surveyed by evaluating the proband’s expectations before the study and personal well-being traits during the study. The primary objective was to identify any physical or psychological area in which the consumption of organic foods produces measurable effects that could provide the basis for further, more specific research. Under the relatively well controlled circumstances of a catholic convent, which was not positively influenced beforehand to organic nutrition, 32 nuns were provided subsequently over 14-day periods with totally conventional and biodynamic diets, respectively. This approach investigated the overall effects of a biodynamic diet, not going into details of single

diet components or production circumstances on the farm level. Anyhow, the farm level may be considered well controlled, because of the relatively strong biodynamic production standards (Demeter International, 2003, Leiber et al., 2006). The concept of food produced using biodynamic methods goes further than the actions of individual constituents, or palatability defined on that basis, because in the case of biodynamic food not only are the foodstuffs themselves taken into account, but also the circumstances in which they originate. Biodynamic production features varied crop rotations, a balanced relationship between plants and animals, organic fertilizers, and avoidance of highly soluble mineral fertilizers and plant protection substances; it also involves applying special biodynamic preparations, often requires more labour, and takes cosmic rhythms into account (Leiber et al. 2006, Koepf,et al., 1976). This method of farming increases biological activity in soil (Mäder et al., 2002) and affects both plants and animals in such a way that, using certain image-giving methods, they can be distinguished from comparable conventionally produced foods (Balzer-Graf, 1987, Balzer-Graf U, 1996, Mäder et al., 1993).

The survey contained four levels of investigations: The first three levels are the mental, the psychic and the physical well-being, investigated by questionnaires, which surveyed the personal experiences of the probands.

The fourth level was the physiological one. Since in adult and elderly people, cardiovascular health closely depends on the diet (Chahoud et al., 2004), parameters of blood pressure and heart rate were measured. The response of immune function of lymphocyte cells to the diet is a relevant issue as well in young (Jarvinen et al., 1999) as in old people (Mocchegiani et al., 2004). Clear evidence for the dependence of lymphocyte subtypes on dietary Vitamin A (Dawson and Ross, 1999, Penn et al., 1991), Vitamin E (Penn et al., 1991), Vitamin C, beta-carotene (Chandra, 2002) and selenium (Alvarado et al., 2005) and zinc (Mocchegiani et al., 2004) exists in the literature (Calder and Kew, 2002). These micronutrients may be enhanced

in organic products (Worthington, 2001, Carbonaro et al., 2002, Caris-Veyrat et al., 2004, Leiber et al., 2005) but the question remains, whether a total organic diet causes changes in immunological parameters. Certain lymphocyte phenotypes were quantitatively evaluated in order to identify any effects in this area.

Materials and Methods

The hypothesis, this study was built on, was, that the consumption of a diet containing mainly bio- dynamic food will positively influence the psychic and mental well-being as well as the personally experienced physical well-being. Further it was hypothesized, that this should be reflected within physiological parameters in the blood.

32 Sisters of a religious christian order, most of them permanently living in a convent in south Germany participated in the study. The probands were aged from 22 to 80 years; the average age was 56. As shown in Figure 1, the total group accidentially was divided in two subgroups, one aged from 22 to 42, the second from 57 to 80. The probands were treated and examined as one group, but additionally, in order to exclude effects of the female menocycle, the group of postmenopausal women (aged above 56 years) was separately evaluated.

<< insert Figure 1 near here >>

All sisters participated for 8 weeks in all meals; if any person had to leave the convent occasionally, she received the food in form of a lunch packet. The primary usual diet in this convent was conventionally based food, the dinner contained mainly ready-made defrosted meals. The first evaluation (E1) was made on the baseline of this diet. After E1 the diet was

changed to freshly confected meals on the basis of conventionally produced food. From now on evaluations were made fresh biodynamic (E3), fresh biodynamic (E4), fresh conventional (E5), ready-made conventional (E6). The term “conventional food” is used for food that was not produced organically. “Biodynamic” means, that at least 85% of the used products were produced and processed according to the international Demeter-standards (Demeter International, 2003), the other 15% were organically grown products.

<<insert Figure 2 near here>>

The biweekly evaluations were conducted using a questionnaire devised specifically for this study by the Centre for Empirical Pedagogical Research, Landau, Germany, six slightly modified versions of which were used for the different test times. The questionnaire consisted of standard procedures for recording psychological well-being (Steyer et al., 1995) and a sum scale of physical complaints (Dlugosch et al. 1995), along with special points systems devised specifically to suit the issues under investigation. The points systems were subjected to appropriate reliability tests wherever possible, and proved sufficiently reliable. In order to ascertain psychological well-being, the subjects were asked to grade 12 adjectives from a choice of five possible responses ranging from “strongly disagree” to “strongly agree”. Further, in the first evaluation (E1), the participants were asked about their expectations about the influence of the biodynamic diet. This was done in a scale from 1 to 5, based on the same principle of questionnaire as explained above.

In this paper only a representative group of parameters is published.

Blood samples were taken every 14 days at 7 a.m. with the subject fasting. A total of 6ml of EDTA blood were drawn using Sarstedt-Monovettes® and immediately sent for processing. Lymphocyte typing was carried out according to the customary flow cytometry procedure

using double staining immunofluorescence techniques (FACScan, Becton Dickinson, Heidelberg). In addition, a differential blood count was also carried out (CC-780, Digitana, Hamburg).

Statistics

The dependence of parameters from the questionnaire as well as blood parameters on the nun's expectations was tested with a one way ANOVA. In cases, were a significance or a tendency for this dependence occurred, a two tailed Pearson correlation was calculated. Because the variables of the questionnaire are all integer variables, changes of the mean are not illustrative enough, especially when these changes range beyond 0.5. Therefore, additionally to the means, the 25% and the 75% quartiles were calculated, in order to illustrate more clearly, how the answers within the proband's group altered.
Differences within any parameter between the different time points were evaluated with tukeys T- Test. All calculations were done once for the total probands and once for the postmenopausal women. All statistics were carried out on SPSS® 14.0.

<<insert Table 1 near here >>

Results

Expectations

The expectations of the nuns regarding the influence of the diet change towards biodynamic processed food ranged for all surveyed topics near the value of 4 (Table 1). This means the expectation of moderately positive changes ('3' would mean no changes, '5' means high positive changes expected). The minimum level was never beyond '3' ('2' would mean the expectation of moderately negative influences).

Experience of the food quality

The rating for the food's taste increased from the baseline diet to the conventional fresh diet (Table 2). Consecutively, the first biodynamic period (E3) was not higher ranked than E2, but the highest rates for taste were matched within the second biodynamic period. In this period (E4), nearly every proband person ranked the taste one unit higher than in the baseline survey (E1). In E5 and E6, the values declined again. In the postmenopausal group this development was basically the same. The digestibility of the food was experienced highest in the two biodynamic periods and lowest after the return to the ready-made conventional meals. This corresponds with the highest absence of stomach problems during the biodynamic periods. Stomach problems however, ought to be on a low level during the total study (75% quartile was always '3' or lower, meaning indifferent or predominantly no correspondence to the question 'did the diet of the past two weeks cause stomach problems?').

<<insert Tables 2 +3 near here>>

Personally experienced physical well-being

The average answer to the question about the personally experienced general health status increased constantly from close to '3' (indifferent) in E1 to '4' (moderately well) in E4 (Table 3). This was less pronounced within the postmenopausal group. Although the lower quartile (25%) always remained at '3', the minimum answer '1' occurred only in E1. In E5 and E6, about one half of the probands declined their answers by one unit, compared to E4.

The personal appreciation of physical fitness constantly increased from E1 to E3; in E4, no further improvement was experienced. In E5 a slight decrease occurred in the total, but not in the postmenopausal group.

Initially ranging around the indifferent value of '3', the answer on the question 'did you feel tired?' constantly declined to a difference of nearly one unit between E1 and E4; in E5 and E6 it increased again. This was even more pronounced within the postmenopausal group.
A slight, but not significant improvement of the sleep from the first to the second biodynamic diet period was experienced.

Personally experienced psychic well-being

The biodynamic periods caused significantly more positive answers on the question 'did you feel relaxed?' (Table 4). In E5 and E6 these values declined, but not to the baseline value of E1. There was no difference in this development between the total and the postmenopausal group.
The direct question about psychic well-being caused a significant better value for the biodynamic periods than for the baseline E1; E2 and E5 were intermediate. In the postmenopausal group, the value already in E4 apparently declined, but this was because of only one person, giving a more negative answer.

<<insert Table 4 near here>>

Personally experienced mental fitness

The mental fitness was ranked highest in the second biodynamic period E4 with a clear and significant difference to E1, E2 and E5 (Table 4). Even E3 was somewhat lower evaluated. These differences were much less pronounced within the postmenopausal group.

Cardiovascular parameters

The systolic blood pressure was significantly lowered from the biodynamic period E3 on.

This decrease lasted also for the conventional fresh period E5. The effect occurred as well in the total as in the postmenopausal group (cf. Tables 5 and 6). The diastolic blood pressure and the pulse did not differ within the total group. A slight reduction of diastolic blood pressure in E3 became significant in the postmenopausal group.

<<insert Tables 5 +6 near here>>

Physiological blood parameters

The values for erythrocytes, thrombocytes, hemoglobin and hematocrit altered between the evaluation periods, which caused significant differences. Anyhow, these differences were neither systematic nor of any physiological relevance.

Within the postmenopausal group, the total leucocytes were significantly decreased during all four periods with freshly prepared meals, regardless of the origin of products (Table 6).

Within the total group no systematic effects on leucocytes were observed (Table 5). The neutrophiles were in both groups significantly decreased from E2 on. For the basophiles a tendency for a similar effect was observed.

A tendencial increase of the lymphocytes from E2 on in both groups was observed. For certain subtypes, namely CD3+, CD19+ and CD 56+ this increase was clear and significant in both groups. For CD 56+ the values decreased again in E5, for the other two types, they remained on the higher level, reached since E2.

Correlations of the questionnaire results with the surveyed expectations of the probands

Dependencies of questionnaire results on the expectations of the probands were tested with a one way ANOVA. Those variables, where no dependency occurred were not further examinated. In the total probands group, the personally experienced mental fitness was

positively correlated with the expected physical fitness (for the biodynamic periods) in E3 and negatively correlated with the expected physical fitness in E5 (Table 7). The experienced physical fitness in E5 was negatively correlated with the expectations towards the biodynamic diet. For the postmenopausal group the latter statement is true, too, but the former only in tendency.

<<insert Table 7 near here>>

Discussion

Whether organically produced food provides a real health advantage compared to conventional food or whether the main advantage is one for the consciousness of the consumer, is from the scientific point of view still an unsolved question (Magkos et al., 2003) The mental aspect is of course an important one at least in the consumer decisions (Köpke, 2005, Torjusen et al., 2004), but it has to be kept in mind also as a real health and well-being issue (Köpke, 2005).

Here, an attempt was made, to evaluate, how "health" develops on the physiological, the psychic and the mental level, and what influence the a priori expectations have on this development during middle-term conversion of a conventional diet to an organic one. More specifically, in the place of organic food a biodynamic diet was used, which means that even higher standards than the international organic standards are applied in the agriculture and food processing (Leiber et al. 2006). A group of nuns voluntarily participated in a nutrition study and received in a sequence with biweekly periods a fresh diet of conventionally grown compounds (which already was a clear change compared to the ready-made conventional food, they usually ate), subsequently a fresh biodynamic diet, then again a fresh conventional and finally the usual ready-made diet.

As was surveyed with the questionnaire, there were moderately positive expectations of the nuns towards the influences of the biodynamic diet on their physical and mental well-being, but only very few and weak correlations with the experienced well-being occurred.

The results on immunological blood parameters show, that the immunological activity, indicated by several lymphocyte subtypes, increased (within physiological orders) with the conversion to freshly prepared meals. The biodynamic food did not increase these activities further. Based on literature it was assumed (not measured), that the biodynamic food in this study contained higher amounts of antioxidants (Carbonaro et al., 2002, Caris-Veyrat et al., 2004, Bergamo et al., 2003) and functional fatty acids (Bergamo et al., 2003, Leiber et al., 2005). Already the freshly prepared conventional meals may have contained increased levels of functional fatty acids, since oxidation during processing is avoided (German, 1999). As well antioxidants (Dawson and Ross, 1999, Penn et al., 1991, Chandra, 2002, Alvarado et al., 2005) as functional fatty acids (Connor, 2000) play an important role within the immune functions and may modulate the immune system to some degree. These substances could have been involved in the effects. However, this study did not focus on the single nutrients, but rather on the total diet, a perspective, which is part of the philosophical background of biodynamics (Leiber et al. 2006) but is also debated within medical science. On this level, the hypothesis, that particularly biodynamic food could influence the measured immunological parameters, was not verified. Rather the difference between ready-made frozen and freshly prepared food seems to have caused the differences.

Blood hemoglobine, hematocrite, leucocytes and erythrocytes did not systematically respond to any of the treatments. The only physiological parameter, which significantly responded particularly to the biodynamic food, was the systolic, and within the postmenopausal women also the diastolic, blood pressure. One main reason could have been increased fibre intake of the test persons during the biodynamic period, which was calculated from their nutrition

diaries (data not shown here). Increased fibre intake was repeatedly proven to decrease blood pressure (Miura and Nakagawa, 2005, Anderson, 2003). Also, the n-3 fatty acids may reduce blood pressure, however, the scientific opinion differs in this issue (Miura and Nakagawa, Valensi, 2005).

Always knowing what they ate the test persons expressed a significant improvement of their well- being in all points they were biweekly asked with the questionnaire. This was true on the physical, the psychic and the mental level. This improvement partly took place already with the conversion of the conventional food from ready-made to freshly prepared meals. Most of the surveyed parameters however, peaked within the biodynamic periods. Also the decline of the personally experienced well-being in the periods, when freshly prepared (E5) and ready-made (E6) conventional food was offered again, indicates some specific biodynamic effect, although it was rarely significant.

The answers on the question ‘did you feel relaxed during the past two weeks?’, most clearly peaked within the two biodynamic periods. This corresponds to the decreased blood pressure in these periods. Mental relaxation and a decreased blood pressure thus represent the parameters, which were positively affected by biodynamic food.

Because of stepwise improvement during periods E2-E4, all other parameters of the questionnaires could also be interpreted as caused by longer lasting time effects of the fresh products, regardless of their origin. This could then also be related to the increased immunological activity since period E2. However, the trend to declining answer categories in period E5 shows that the peaks during the biodynamic periods were at least partly caused by this particular diet.

The data of this study do not provide an explanation for the subjectively experienced biodynamic effect on body, soul and mind, which not means that there is non. Although not explanatory in natural scientific terms, the philosophy, standing behind biodynamic

agriculture (Leiber et al. 2006) has to be considered here. This philosophy assumes life forces, which constitute the living organisms out of a spiritual dimension of the world. The biodynamic applications in agriculture and the careful food processing should perpetuate the integrity of these constituting life forces. By image giving methods, such as copper-chloride-christallography (Balzer-Graf, 1987), it could be shown repeatedly, that biodynamic food causes more structured images than conventional and even other than organic food (Balzer-Graf, 1987, Balzer-Graf U, 1996, Mäder et al., 1993). These structures are interpreted as caused by the integer life forces (Balzer-Graf, 1987), which should contribute to the nutrition of man as well as physical components. This perspective can not be covered by a common scientific survey, but this is the background of the biodynamic understanding of nutrition, and thus a biodynamic interpretation of the present study results would take the influence of these spiritual forces into account.

What is the scientific relvance of such a personal, non blind, evaluation of well-being, the more if it shall depend on a diet explicitly claimed to be of an extraordinary high nutritional, environmental and ethical quality?

Blinded study designs are known to cause certain biases, particularly when they partly rely on questionnaires, because the test persons probably adapt their behaviour and answers to the special situation (Kiene et al., 1998), they are afraid of answering wrong and thus produce false negative or false positive answers. This is not a problem of blinding alone. We have to presume to some amount the same effect in the present study. This certainly lowers the reliability of the questionnaire's results. On the other hand, the test persons were not anthroposophists, but belonged to a catholic convent. Therefore, their attitude towards the biodynamic methods should have been sceptically rather than emphatic. It can be excluded, that these persons expected positive effects due to their worldview. Further, there were only very few and weak correlations between the nuns a priori expectations on the impact of the

biodynamic diet and their a posteriori ranking of the occurred effects.

On the other hand, a normal adult person usually knows, what he does, and particularly the choice of organic food is highly conscious (Yiridoe et al., 2005, Torjusen et al., 2004). Psychic and mental well-being of persons consuming organic (and certainly even more if biodynamic) food is always realised on the background, that persons know, what they eat. This probably can function as a relevant part of the influence on well-being (Köpke, 2005). We have then, of course, different sources of mental well-being, namely internal psychological, external ideal (in the biodynamic sense; see above) and external physiological sources, which we can not fully differentiate with the methods of this study. It seems, that the physiological sources dominate generally in the freshly prepared diets, whereas the psychological sources are additionally emphasized with the biodynamic food. About the ideal sources, no statement is possible out of this study. But in sum, there is no reason to contradict, that an improvement of the personal well-being of the nuns occurred. The psychological component of this coherence could not have been evaluated with any blinded study.

Conclusion

On the physiological level the fresh preparation of a diet has a clearer influence on immunological parameters than the biodynamic vs. conventional origin of the food. However, the biodynamic origin clearly influences blood pressure and personal experienced well-being on different levels.The explicit pathways of impacts are still unclear. The authors understand this study as a pilot study in order to bring up the discussion about research on the physiological and psychological impacts of total diets on the human being.

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Table 1. Expectations of the study's probands on the influences of biodynamic food

	Dig-estion	Eating behaviour	Health	Resis-tence	Sleep	Physical fitness	Psychic condition	Mental fitness
N	28	30	28	28	28	27	28	28
Mean	3.79	4.03	4.14	4.25	3.54	3.89	4.04	4.07
s.e.	0.155	0.165	0.136	0.136	0.142	0.156	0.160	0.172
Quartile 25	3	3	4	4	3	3	3	3
Quartile 75	4.75	5	5	5	4	5	5	5

Answer categories: 1=clearly negative, 2=moderately negative, 3=indifferent, 4=moderately positive, 5=clearly positive

Table 2. Food quality as assessed by the probands retrospectively after each period.

		E1	E2	E3	E4	E5	E6
The food of the past two weeks was well tasting							
Total group	Mean	3.75^{b}	4.22^{a}	4.19^{a}	4.40^{a}	3.93^{b}	3.70^{b}
	s.e.	0.183	0.134	0.192	0.153	0.15	0.179
	Quartile25	3	4	4	4	3	3
	Quartile75	4.75	5	5	5	4	4
Postmenopausal group	Mean	3.58^{b}	4.18^{a}	4.07^{ab}	4.38^{a}	4.13^{a}	3.57^{b}
	s.e.	0.207	0.196	0.3	0.202	0.18	0.228
	Quartile25	3	3.5	3	4	4	3
	Quartile75	4	5	5	5	5	4.25
The food of the past two weeks was well digestible							
Total group	Mean	3.65^{b}	3.97^{ab}	4.24^{y}	4.25^{a}	3.8^{ab}	3.36^{b}
	s.e.	0.162	0.136	0.166	0.162	0.216	0.181
	Quartile25	3	3	3.5	4	3	3
	Quartile75	4	4.5	5	5	5	4
Postmenopausal group	Mean	3.50^{cd}	3.94^{bc}	4.40^{a}	4.20^{ab}	3.93^{bc}	3.25^{d}
	s.e.	0.146	0.171	0.214	0.223	0.305	0.194
	Quartile25	3	3	4	3	3	3
	Quartile75	4	4.25	5	5	5	3
The food of the past two weeks caused stomach problems							
Total group	Mean	2.07^{a}	1.93^{ab}	1.89^{ab}	1.65^{b}	2.30^{a}	2.18^{a}
	s.e.	0.154	0.194	0.221	0.189	0.197	0.179
	Quartile25	1.25	1	1	1	1	1
	Quartile75	3	3	3	2	3	3
Postmenopausal group	Mean	2.00^{ab}	2.05^{ab}	1.81^{ab}	1.73^{b}	2.25^{a}	2.41^{a}
	s.e.	0.171	0.235	0.262	0.248	0.25	0.228
	Quartile25	1.5	1	1	1	1	1.5
	Quartile75	2.5	3	3	2	3	3

Answer categories: 1=not appropriate, 2=rarely appropriate, 3=indifferent, 4=rather appropriate, 5=fully appropriate

Table 3. Personal assessment of the physical well-being of the probands retrospectively after each period.

		E1	E2	E3	E4	E5	E6
How would you range your health of the past two weeks?[k]							
Total group	Mean	3.75[b]	4.22[a]	4.19[ab]	4.40[a]	3.93[b]	3.70[b]
	s.e.	0.183	0.134	0.192	0.153	0.15	0.179
	Quartile25	3	4	4	4	3	3
	Quartile75	4.75	55	5	5	4	4
Postmenopausal group	Mean	3.39[b]	3.53[ab]	3.82[ab]	4.00[a]	3.55[ab]	3.63[ab]
	s.e.	0.191	0.155	0.198	0.162	0.144	0.197
	Quartile25	3	3	3	3	3	3
	Quartile75	4	4	4.75	5	4	4
How would you range your physical fitness in the past two weeks?[k]							
Total group	Mean	3.31[b]	3.55[ab]	3.82[ab]	3.88[a]	3.24[ab]	Nd
	s.e.	0.227	0.161	0.142	0.167	0.24	
	Quartile25	2	3	3	3	2.5	
	Quartile75	4	4	4	5	4	
Postmenopausal group	Mean	3.40	3.71	3.90	3.85	3.79	Nd
	s.e.	0.306	0.254	0.18	0.222	0.3	
	Quartile25	3	3	3.75	3	3	
	Quartile75	4	4.5	4	4.5	5	
Did you feel tired in the past two weeks?[l]							
Total group	Mean	3.40[a]	2.88[b]	2.77[b]	2.56[b]	2.92[ab]	2.96[ab]
	s.e.	0.207	0.224	0.169	0.18	0.241	0.225
	Quartile25	2.75	2	2	2	2	2
	Quartile75	4	4	3.25	3	4	4
Postmenopausal group	Mean	3.53[a]	3.00[ab]	2.79[b]	2.53[b]	2.80[b]	3.00[ab]
	s.e.	0.241	0.278	0.223	0.208	0.251	0.294
	Quartile25	3	2	2	1	2	1
	Quartile75	4	4	3.25	3	4	4

[k]Categories of answers: 1= very low, 2=low, 3=indifferent, 4=high, 5=very high
[l]Categories of answers: 1=no, 2=seldom, 3=indifferent, 4=sometimes, 5=oftenly

Table 4. Personal assessment of the psychic and mental well-being of the probands retrospectively after each period.

		E1	E2	E3	E4	E5	E6
Did you feel relaxed in the past two weeks?[k]							
Total group	Mean	2.82[c]	2.96[bc]	3.50[a]	3.48[a]	3.24[ab]	3.08[b]
	s.e.						
	Quartile25	2	3	3	3	3	2.5
	Quartile75	3	3	4	4	4	4
Postmenopausal group	Mean	2.76[c]	2.93[c]	3.73[a]	3.42[a]	3.29[ab]	2.93[bc]
	s.e.						
	Quartile25	2	3	3	3	3	2
	Quartile75	3.5	3	4	4	4	4
How would you range your psychic well-being in the past two weeks?[l]							
Total group	Mean	3.31[b]	3.50[b]	3.92[a]	3.92[a]	3.46[b]	Nd
	s.e.	0.133	0.141	0.162	0.169	0.186	
	Quartile25	3	3	3	3	3	
	Quartile75	4	4	5	5	4	
Postmenopausal group	Mean	3.33[b]	3.56[b]	4.15[a]	3.92[ab]	3.67[ab]	Nd
	s.e.	0.159	0.182	0.222	0.239	0.27	
	Quartile25	3	3	3.5	3	3	
	Quartile75	4	4	5	5	5	
How would you rank your mental fitness in the past two weeks?[l]							
Total group	Mean	3.08[c]	3.31[c]	3.48[b]	3.85[a]	3.04[c]	Nd
	s.e.	0.192	0.15	0.139	0.154	0.212	
	Quartile25	2.75	3	3	3	2	
	Quartile75	4	4	4	4.25	4	
Postmenopausal group	Mean	3.40	3.29	3.45	3.64	3.62	Nd
	s.e.	0.273	0.239	0.207	0.169	0.241	
	Quartile25	3	3	3	3	3	
	Quartile75	4	4	4	4	4	

[k]Categories of answers: 1=very low, 2=low, 3=indifferent, 4=high, 5=very high
[l]Categories of answers: 1=no, 2=seldom, 3=indifferent, 4=sometimes, 5=often

Table 5. Blood pressure, pulse and physiological blood parameters in the total test persons group.

		E1	E2	E3	E4	E5	E6
Systolic blood pressure mm Hg	Mean	141.6[a]	139.3[a]	130.6[b]	132.4[ab]	132.2[ab]	
	s.e.	4.5	5.35	4.5	4.24	4.4	
	N	26	23	23	24	24	
Diastolic blood pressure mmHg	Mean	83.2	81.9	78.7	79.3	79.3	
	s.e.	2.18	2.56	2.74	2.69	2.39	
	N	26	23	23	24	24	
Pulse beats/min.	Mean	72.8	72.5	70.6	70.9	72.7	
	s.e.	3.26	2.7	3.11	2.56	2.72	
	N	24	22	22	23	23	
Erythrocytes 10^6/µl	Mean	4.66[c]	4.91[a]	4.82[b]	4.64[c]	4.66[c]	4.77[b]
	s.e.	0.077	0.082	0.076	0.076	0.086	0.077
	N	28	28	27	27	24	24
Thrombocytes 10^3/µl	Mean	265.5[a]	252.1[b]	262.6[a]	261.7[a]	264.8[a]	273.6[a]
	s.e.	10.76	9.7	9.07	9.96	13.76	11.97
	N	28	28	28	28	25	25
Hemoglobin g/100ml	Mean	14.1[b]	14.6[a]	14.2[b]	13.8[c]	13.8[c]	13.9[c]
	s.e.	0.29	0.32	0.3	0.3	0.33	0.32
	N	27	27	27	27	24	24
Hematocrit %	Mean	40.0[b]	42.4[a]	41.5[b]	39.3[c]	39.6[c]	40.5[b]
	s.e.	0.82	0.84	0.78	0.73	0.86	0.75
	N	27	27	27	27	24	24
Leucocytes 10^3/µl	Mean	6.29	6.02	6.17	5.90	5.99	6.22
	s.e.	0.27	0.24	0.251	0.264	0.245	0.242
	N	28	27	27	27	24	24
Lymphocytes % of leucocytes	Mean	28.6[b]	29.1[b]	30.7[a]	31.4[a]	31.3[a]	31.1[a]
	s.e.	1.27	1.38	1.52	1.42	1.44	1.51
	N	27	27	27	24	24	24
Natural killer cells (CD 56+) cells/µl	Mean	286.4[b]	347.7[a]	314.4[a]	324.2[a]	296.2[b]	
	s.e.	25.18	35.09	27.16	29.84	21.65	
	N	22	22	27	26	26	
T-cells (CD3+) cells/µl	Mean	1005[c]	1324[ab]	1270[b]	1332[ab]	1368[a]	
	s.e.	77.8	98	82.9	91.7	95.8	
	N	22	22	27	26	26	
B-cells (CD19+) cells/µl	Mean	128.6[b]	211.2[a]	206.3[a]	207.3[a]	210.0[a]	
	s.e.	10.82	17.05	18.4	20.71	21.35	
	N	22	22	27	26	26	
Eosinophyles % of leucocytes	Mean	2.57	2.98	2.67	2.99	3.01	2.85
	s.e.	0.206	0.332	0.237	0.22	0.243	0.27
	N	26	26	27	27	24	24
Basophiles % of leucocytes	Mean	0.846[a]	0.775[a]	0.664[b]	0.784[ab]	0.644[c]	0.720[ab]
	s.e.	0.0693	0.0757	0.058	0.0848	0.0681	0.0835
	N	28	28	28	25	25	25
Neutrophiles % of leucocytes	Mean	60.7[a]	58.6[ab]	57.6[b]	57.3[b]	56.6[b]	56.1[b]
	s.e.	1.71	1.41	1.48	1.38	1.45	1.31
	N	28	28	28	28	25	25

Table 6. Blood pressure, pulse and physiological blood parameters in the postmenopausal test persons group.

		E1	E2	E3	E4	E5	E6
Systolic blood pressure mm Hg	Mean	152.65[a]	152.92[a]	141.38[b]	143.50[b]	144.71[ab]	
	s.e.	4.95	5.46	6.08	5.01	5.23	
	N	17	13	13	14	14	
Diastolic blood pressure mm Hg	Mean	87.3[a]	86.9[a]	83.9[b]	85.5[ab]	84.1[ab]	
	s.e.	2.52	2.93	3.56	2.88	3.2	
	N	17	13	13	14	14	
Pulse beats/min.	Mean	72.9	74.3	70	70.9	70.7	
	s.e.	4.27	4.08	4.07	3.25	3.18	
	N	15	12	12	14	14	
Erythrocytes 10^6/µl	Mean	4.64[b]	4.90[a]	4.79[a]	4.62[b]	4.61[b]	4.74[a]
	s.e.	0.088	0.12	0.108	0.092	0.115	0.1
	N	18	18	16	16	15	15
Thrombocytes 10^3/µl	Mean	280.3	263.9	272.5	272.5	280.9	284.1
	s.e.	14.45	11.06	13.35	14.28	17.78	14.67
	N	18	18	16	16	15	15
Hemoglobin g/100ml	Mean	14.06[bc]	14.60[a]	14.30[ab]	13.88[c]	13.78[c]	13.92[c]
	s.e.	0.341	0.439	0.434	0.402	0.47	0.42
	N	18	18	16	16	15	15
Hematocrit %	Mean	40.2	42.7	41.6	39.8	39.8	40.9
	s.e.	1.03	1.18	1.04	0.98	1.22	1.02
	N	18	18	16	16	15	15
Leucocytes 10^3/µl	Mean	6.52[a]	5.98[b]	6.24[b]	5.94[b]	6.12[b]	6.56[a]
	s.e.	0.333	0.231	0.278	0.276	0.324	0.341
	N	18	18	16	16	15	15
Lymphocytes % leucocytes	Mean	28.7	29.6	29.5	29.2	30.6	29.5
	s.e.	1.57	1.66	1.99	1.94	1.74	1.99
	N	18	18	16	16	15	15
Natural killer cells (CD 56+) cells/µl	Mean	340.8[b]	410.8[a]	358.1[ab]	372[ab]	333.3[b]	
	s.e.	37.95	55.93	41.91	43.83	32.13	
	N	12	12	16	15	15	
T-cells cells/µl	Mean	1060[b]	1334[a]	1232[a]	1306[a]	1335[a]	
	s.e.	114	142	115.8	131.9	140.3	
	N	12	12	16	15	15	
B-cells cells/µl	Mean	134.2[b]	211.7[a]	186.9[a]	188.7[a]	193.3[a]	
	s.e.	16.44	24.61	25.47	27.6	27.46	
	N	12	12	16	15	15	
Eosinophyles % of leucocytes	Mean	2.64[b]	3.22[a]	2.83[b]	2.69[b]	3.13[a]	2.81[ab]
	s.e.	0.234	0.411	0.328	0.278	0.315	0.301
	N	18	18	17	15	15	15
Basophiles % of leucocytes	Mean	0.828[a]	0.853[a]	0.724[b]	0.738[ab]	0.680[b]	0.753[ab]
	s.e.	0.0812	0.092	0.0678	0.1032	0.0932	0.1023
	N	18	17	17	16	15	15
Neutrophiles % of leucocytes	Mean	60.2[a]	57.5[ab]	57.6[ab]	58.1[ab]	56.3[b]	57.0[ab]
	s.e.	2.45	1.68	1.94	1.97	1.71	1.85
	N	18	18	16	16	15	15

Table 7. Correlations between expectation and observation scores as ranked in questionnaire by the test persons.

	E1	E2	E3	E4	E5
Total group					
	Observations	Mental fitness			
Expectations					
Mental fitness	-0.188	-0.071	0.234	0.143	-0.324
N	24	27	21	24	23
Physical fitness	-0.3	-0.108	0.518*	0.342	-0.465*
N	24	27	21	23	23
	Observations	Physical fitness			
Expectations					
Mental fitness	-0.329	-0.145	-0.15	0.062	-0.179
N	23	27	21	23	24
Physical fitness	-0.393	-0.124	0.143	0.272	-0.587**
N	23	26	21	22	24
Postmenopausal group					
	Observations	Mental fitness			
Expectations					
Mental fitness	-0.317	-0.166	-0.303	-0.185	-0.454
N	13	16	10	13	12
Physical fitness	-0.411	-0.240	0.327	0.117	-0.440
N	13	16	10	12	12
	Observations	Physical fitness			
Expectations					
Mental fitness	-0.438	-0.238	-0.413	-0.221	-0.069
N	12	16	10	12	13
Physical fitness	-0.39	-0.155	-0.05	-0.029	-0.617*
N	12	15	10	11	13

*significant at P<0.05; ** significant at P<0.01

Figure 1

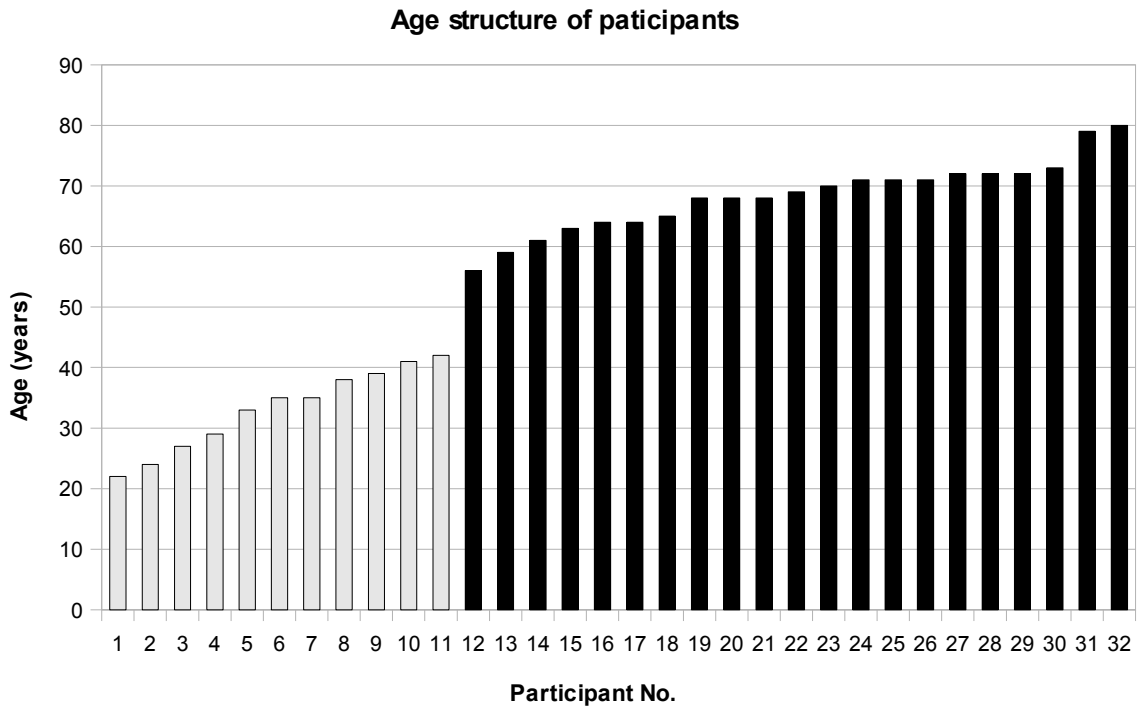

Figure 1: *Age structure of the participants. Black bars indicate the postmenopausal subgroup.*

Figure 2

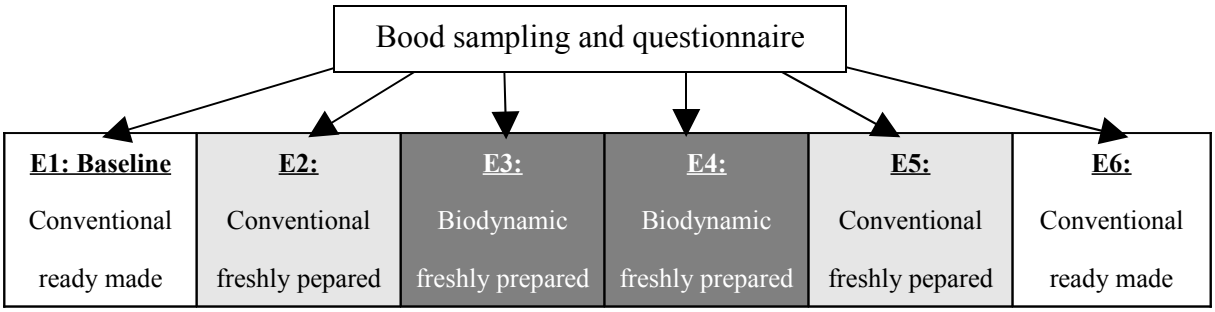

Figure 2: *Schedule of the study. Each period lasted exactly for two weeks. The respective diets were served at breakfast, lunch and dinner.*