The understanding of nutrition is continuously developing, and some important insights were gained in recent years. Apart from the function of meeting the body's requirements of nutrients and energy, scientific knowledge about health beneficial properties of some food ingredients increases. Dietary fibre, vitamins, minerals and phytochemicals are often the subject of research [1]. The recommendations of national and international institutions like the German Nutrition Society (DGE) and the World Cancer and Research Fund (WCRF) take into account recent knowledge about the preventive potential of some nutrients. Their food guidelines emphasise foods rich in nutrients with possible health promoting effects like fruit and vegetables [2, 3].

At the same time, manufacturers of vitamin and mineral supplements promote their use for health reasons. The assumption that dietary supplements are beneficial to human health may be supported by positive associations of micronutrients and some diseases, e.g. the common cold or cardiovascular diseases and cancer, observed in epidemiological studies. Moreover, people may suspect that natural foods have lost some of their micronutrient richness. Others may think they need a higher nutrient intake because of a high physical activity level. For some persons it may be just easier to maintain a healthful diet by using dietary supplements at least temporarily [4-7]. As a result, the frequency of the use of vitamin and mineral supplements has considerably increased in Germany as well as in several other countries [8].

Nevertheless, a well-balanced and varied diet generally provides sufficient amounts of vitamins and minerals for normal development and a healthy life. In this situation it has become mandatory to assess the prevalence of vitamin and mineral supplement use, the extent of micronutrient intake from these supplements as well as to determine population groups with an increased use of dietary supplements. At present, it is unclear which is the exact role that micronutrients play in the development and course of several diseases or their risk factors. An observed beneficial effect may be attributed to the activity of micronutrients or may be the result of a general healthy diet or lifestyle. Possibly, vitamins and minerals contribute to human health more effectively in combination with other dietary compounds as consumed in its natural form.

The presented thesis focuses on diet and health related aspects of the use of vitamin C, vitamin E, folate and other B vitamin, multivitamin and mineral supplements as dietary supplements in Germany. All analyses are based on data of the representative German National Health Interview and Examination Survey and the integrated German Nutrition Survey, which were conducted in 1998 on non-institutionalised German residents, aged 18-79 years [9, 10].

Terminology and general information

Vitamins and minerals are chemical substances that are essential for human metabolism. Only vitamin A, vitamin D and niacin can partly be synthesised from precursors by the human body itself. Our foods contain a wide range of vitamins and minerals but in very variable concentrations and, in comparison to the macronutrients fat, carbohydrate and protein, in considerably lower amounts. A well-balanced diet is, therefore, necessary for sufficient vitamin and mineral intake. However, compared with macronutrients the quantity needed by the human body is much lower, so that vitamins and minerals are also referred to as micronutrients. The metabolism of vitamins and minerals does not provide energy. However, vitamins and minerals are indispensably involved in the utilisation of energy providing macronutrients. There is hardly a synthesis, a signal transmission or a substance carriage without a participation of at least one of the vitamins and minerals. Today, clinical micronutrient deficiency diseases with clear anatomical, functional and metabolic lesions like scurvy, beriberi or iron deficiency anaemia have become rare in industrial countries. However, inadequate micronutrient intakes which are generally accompanied by several unspecific symptoms like nausea, indigestions or disorders in the growth of hair and nails still occur. They are mainly caused by low food intake, resorption disorders in the intestinal tract and/or uncovered additional requirements, for instance during pregnancy or lactation. An extremely high micronutrient intake could lead to intoxication, e.g. as described for the vitamins A, D and E [1, 11-15].

According to a directive of the European Parliament and of the Council on the approximation of the laws of the Member States relating to food supplements, which was presented by the European Commission in June 2002, v*itamin and mineral supplements* are concentrated sources of vitamins and minerals, alone or in combination, that are marketed in dose forms like tablets, capsules or pastilles or some forms of liquids and powders [16]. The directive regulates dispensing and labelling of the supplements as foods with the purpose to supplement the normal diet. In 2000, the Germans spent the considerable sum of more than 350 Mio. € on vitamin and mineral supplements that are available in pharmacies, chemist's shops and supermarkets [17]. At present, vitamin and mineral supplements are subject to the German Foods and Essential Commodities Act ('Lebensmittel- und Bedarfsgegenständegesetz'). According to Article 1 of this Act, they are defined as foods that predominantly serve the purpose of nutrition and savour [18]. Until 31 July 2003, the EU-directive has to be put into national legislation by the Federal Ministry of Consumer protection, Nutrition and Agriculture.

Characterisation of regular vitamin and mineral supplement users

The German Nutrition Survey 1998 provides population-based information on vitamin and mineral supplement use as part of a comprehensive assessment of dietary behaviour of 1763 men and 2267 women, aged 18-79 years. The use of dietary supplements is very common in Germany. In total, 38% of men and 48% of women supplement their diet with micronutrients.

Figure 1 Regular supplement users by gender

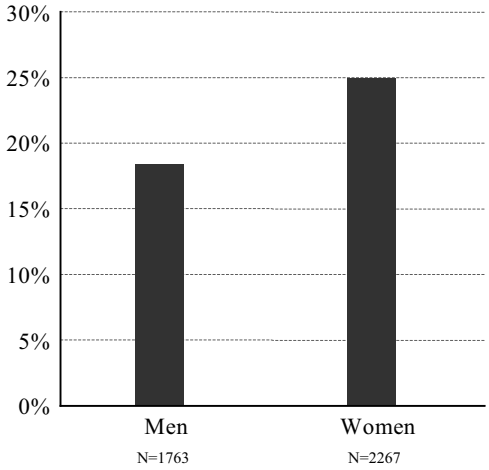
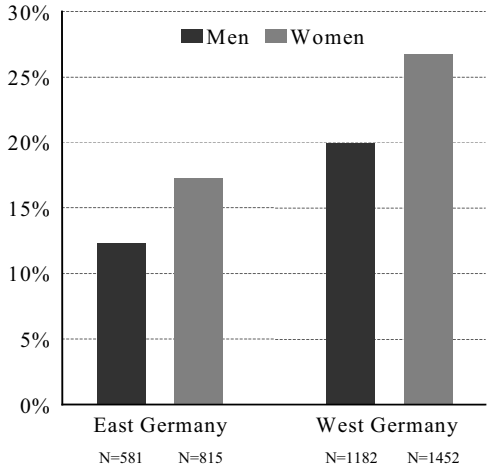
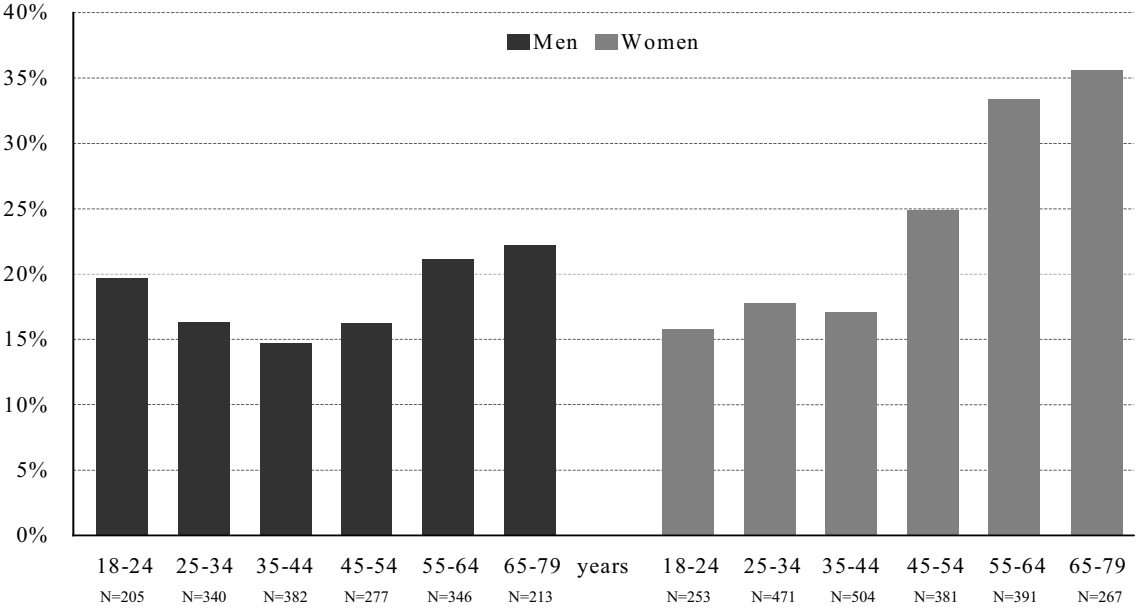


Figure 2 Regular supplement users in East and West



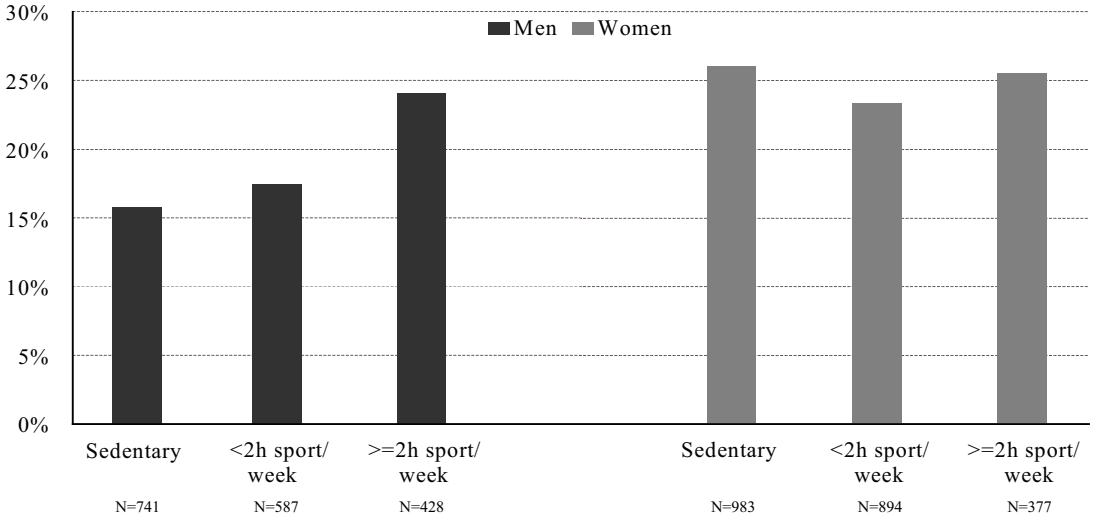
The percentage of regular users who use supplements at least once a week is 18% among men and even 25% among women (Figure 1). The most popular supplements used by men and women are multivitamin and vitamin C supplements, but also mineral supplements are used quite frequently. The prevalence of regular supplement use is generally higher in the female population and for both men and women in the western part of Germany (Figure 2).

Figure 3 Regular supplement users by age



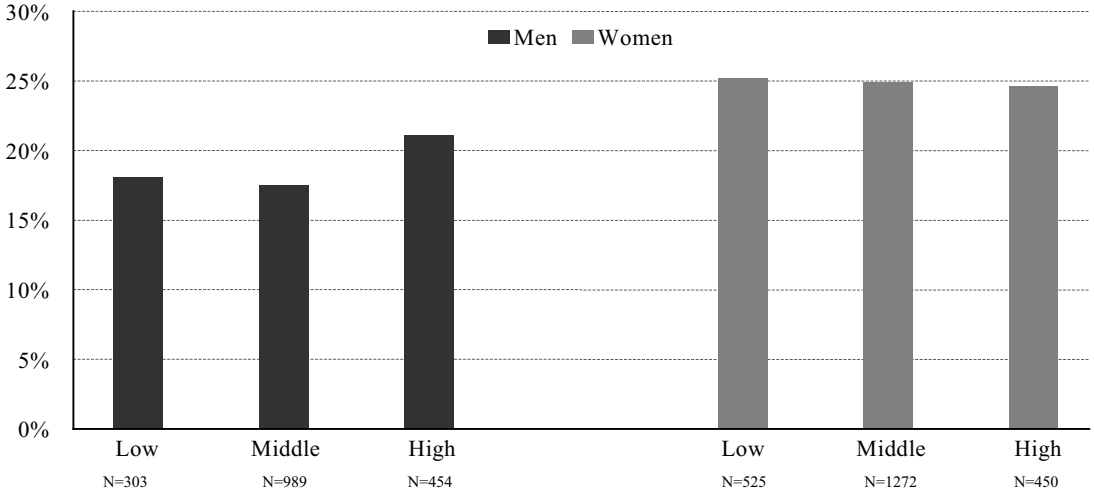
Whereas male regular users are more likely to belong to the younger and older age groups, the percentage of female regular users generally grows with increasing age (Figure 3). The gender specific percentages of regular users in relation to the level of sport activity are presented in Figure 4. The percentage of male regular users is highest among those who are physically active 2 or more hours per week. In contrast, the percentage of female regular users is highest in the group of sedentary women.

Figure 4 Regular supplement users by sport activity



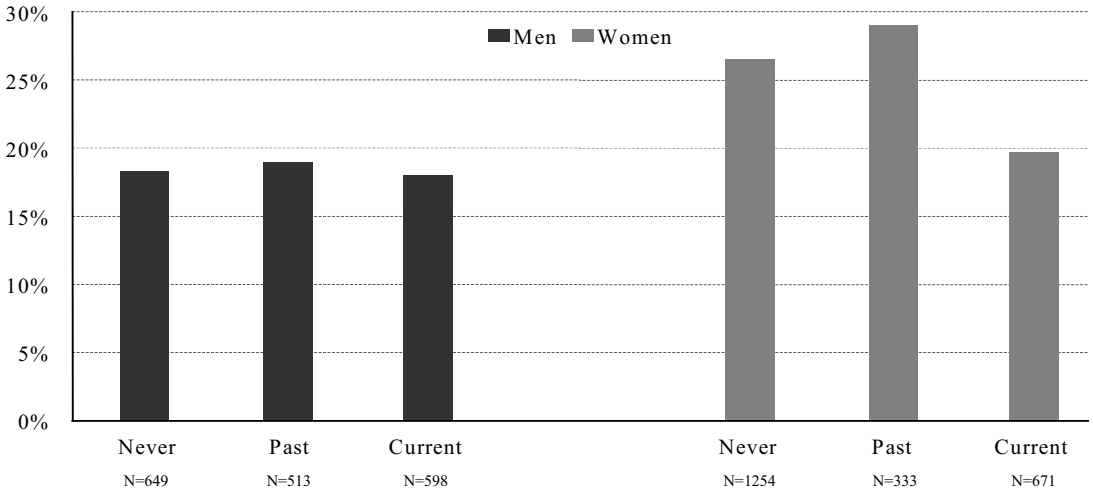
The highest percentage of male regular users is found in the group with the highest level of socio-economic status (SES) while there is a relatively equal distribution of female regular users on the different groups of SES (Figure 5).

Figure 5 Regular supplement users by socio-economic status



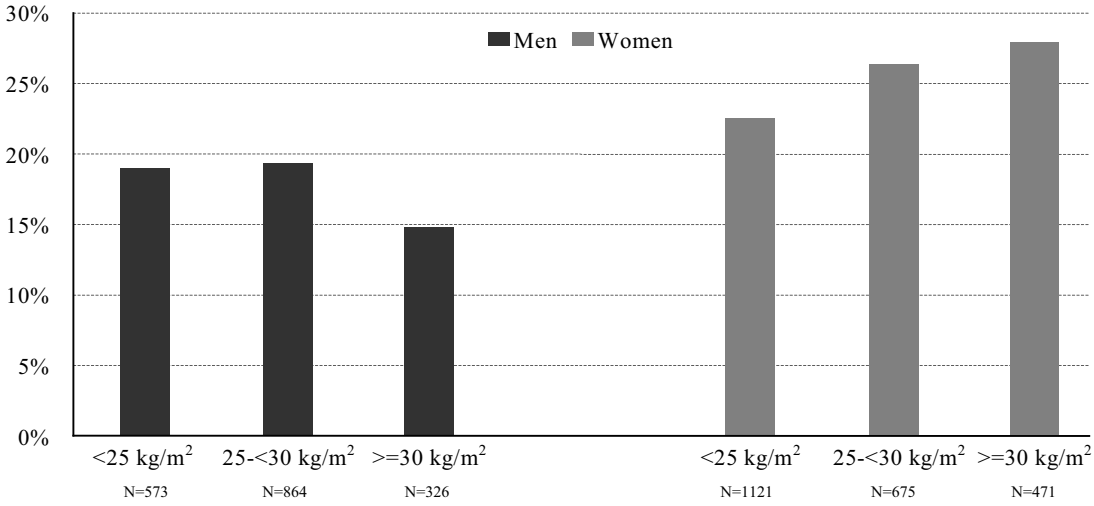
As far as smoking status is concerned, the percentage of male regular users is only slightly differing between the groups of never smokers, ex-smokers and current smokers. In contrast, the percentage of female regular users is highest for those who smoked in the past and lowest for those who are current smokers (Figure 6).

Figure 6 Regular supplement users by smoking status



The percentages of regular users of both genders in relation to groups of body mass index (BMI) are presented in Figure 7. The percentage of male regular users is lowest in the highest BMI group of 30 kg/m^2 or more while the percentage of female regular users increases with increasing groups of BMI.

Figure 7 Regular supplement users by body mass index



In general, the vitamin intakes of regular users are more in line with current German reference intakes than that of nonusers. On the one hand, this is due to a generally higher vitamin intake from natural foods by regular users. Their dietary intake of vitamins C and E, and for

women additionally the dietary intake of biotin and folate, is significantly higher compared with the intake of nonusers. This may indicate a more health conscious food choice of regular users in general. On the other hand, supplemental intake contributes substantially to the total vitamin intake of regular users of both genders. Their vitamin intakes are, on average, 22% higher than that of nonusers. However, several regular users as well as nonusers seem to have a relatively low intake of some vitamins. This applies for instance to folate, vitamin E and pantothenic acid, and for women additionally to biotin. Nevertheless, the percentage of persons whose vitamin intake is below the current German reference intake is generally lower among regular users compared to nonusers. In this context it has to be mentioned that the reference intakes do not mirror individual requirements but target values. In conclusion, some men and women may benefit from supplementing their diet on a regular basis. Nevertheless, the use of dietary supplements is generally not necessary, since often only small changes in food choice lead to sufficient vitamin intake.

The information on supplement use in Germany is presented also in a recent publication entitled “Im Blickpunkt: Vitamin- und Mineralstoffsupplemente” [19]. Since the purpose of this publication was merely to describe the current situation, no statistical testing was performed. However, separate multiple logistic regression models have been performed. We observed a significant association of female gender with regular vitamin and mineral supplement use. Gender specific models show a significant association of increasing age and ex-smoking among women and a high level of sport activity (2 or more hours per week) among men with regular supplementation. The percentage of regular users is also significantly higher for persons who live in former West than in former East Germany.

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