Summary
The human body produces vitamin D in the skin, under exposure to direct sunshine. Vitamin D can also be obtained from food (e.g. fatty fish) and supplements. Insufficient exposure to direct sunlight, covering of the skin, and a diet that is low in vitamin D have been shown to contribute to low serum 25-hydroxyvitamin D [25(OH)D] concentrations. Additionally, vitamin D synthesis is lower in a heavily pigmented skin than in a lighter skin, and this has led to the observation that vitamin D deficiency is more common in dark-skinned individuals living in northern countries.

In the years 2000-2001, two pilot studies were performed in the Netherlands. They both found that more than 80% of the non-western immigrant women was vitamin D deficient. Vitamin D deficiency leads to secondary hyperparathyroidism and, in later stages, to impaired bone mineralization, rickets in children and osteomalacia in adults. Although the level of evidence for causality is poor to moderate, several diseases have been associated with vitamin D deficiency. The health status of non-western immigrant groups usually is worse compared to the autochthonous population, which may be, partly, the result of their vitamin D status.

The studies presented in this thesis have been performed to estimate:

1) the prevalence of vitamin D deficiency among non-western immigrant groups;
2) the relative contribution of the known determinants of vitamin D deficiency;
3) the association between vitamin D deficiency and potential consequences, which could be studied well in a general population (muscle strength, muscle pain, functional limitations, and diabetes mellitus).

1) To estimate the prevalence of vitamin D deficiency among non-western immigrant groups. The prevalence of vitamin D deficiency in a general multiethnic population in the Netherlands is presented in Chapter 2. A total of 613 adults aged 18-65 years from a random sample from ten general practices in the Netherlands (52°N, 2003–05), participated in our cross-sectional study. The prevalence of vitamin D deficiency (serum 25(OH)D < 25 nmol/l) was higher in Turkish (41%), Moroccan (37%), Surinam South Asian (51%), Surinam Creole (45%), sub-Saharan African (19%) and other adults (29%) compared to the indigenous Dutch (6%).

The prevalence of vitamin D deficiency among pregnant non-western women in The Hague is presented in Chapter 3. Midwives whose practice was visited by a large number of non-western immigrants added the assessment of serum 25(OH)D to the standard blood test given to women who visited the practice during week 12 of pregnancy. In the midwives’ files (June 2002 through March 2004), vitamin D concentrations of 358 women were found. The prevalence of vitamin D deficiency (serum 25(OH)D < 25 nmol/l) was higher in Turkish (84%), Moroccan (81%), and other non-western women (59%) compared to the western women (8%). Serum 25(OH)D was below the 7 nmol/l detection limit in 22% of the Turkish women.
An overview of the prevalence of vitamin D deficiency among non-western populations in Europe and their countries of origin is presented in Chapter 4. A literature search was performed, which consisted of terms referring to vitamin D or vitamin D deficiency, prevalence or cross-sectional studies, and countries or ethnicity. Titles and abstracts were reviewed to identify studies on population-based mean serum 25(OH)D concentrations among Turkish, Moroccan, Indian and sub-Sahara African populations in Europe, Turkey, Morocco, India and sub-Sahara Africa. The vitamin D status of immigrant populations in Europe was poor compared to the indigenous European populations. The vitamin D status of studied populations in Turkey and India varied and was either similar to the immigrant populations in Europe (low), or similar to or even higher than the indigenous European populations (high).

2) To estimate the relative contribution of the known determinants of vitamin D deficiency.

The estimation of the relative contribution of the known determinants of vitamin D deficiency was also done in the cross-sectional study presented in Chapter 2, among the 613 adults aged 18-65 years from ten general practices in the Netherlands. Ethnic group, season and pregnancy or breastfeeding were related to vitamin D status. Modifiable, significant determinants (standardized regression coefficients) for serum 25(OH)D concentration were, in order of relative influence: consumption of fatty fish (0.160), use of vitamin D supplements (0.142), area of uncovered skin (highest category 0.136; middle category 0.028), use of tanning bed (0.103) consumption of margarine (0.093) and preference for sun (0.089). We found no significant modification of ethnic group on the effect of sunlight determinants.

3) To estimate the association between vitamin D deficiency and potential consequences, which could be studied well in a general population (muscle strength, muscle pain, functional limitations and diabetes mellitus).

Among the participants of the cross-sectional study presented in chapter 2, measures of muscle strength, muscle pain, functional limitations and diabetes mellitus were performed. Data of 17 participants were excluded from the analyses because they were pregnant, resulting in suitable data of 596 participants. For the analysis of the association between vitamin D deficiency and diabetes mellitus, data of 109 participants was excluded because fasting glucose concentration was missing, resulting in suitable data of 487 participants. Associations between vitamin D status and muscle strength, muscle pain functional limitations, adjusted for gender, age, BMI and ethnic group, are presented in Chapter 5. The associations were ambiguous, as can be seen from two contradictory examples: hand grip strength and muscle pain in the upper legs. Hand grip strength was lower among vitamin D deficient (VDD) men (Beta =-2.53; 95% Confidence Interval = -5.32 – 0.27), although not significantly; there was no association among women (Beta =0.69; -0.76 – -2.13). Among Western (Odds Ratio (OR) =4.96; 0.98 – 25.15) and Turkish/North African (OR =1.28; 0.68 – 2.43) populations, muscle pain...
in the upper legs was more often reported in the VDD group, although it was not significant in both groups. Among the Black population, muscle pain in the upper legs was significantly less often reported in the VDD group (OR =0.41; 0.18 – 0.97).

The association between vitamin D status and diabetes mellitus is presented in Chapter 6. Vitamin D deficiency (34%), insufficiency (40%) and diabetes mellitus (12%) were highly prevalent. After adjustment for age, gender, BMI, season and ethnic group, diabetes mellitus was positively, but not significantly, associated with vitamin D deficiency (OR =1.70; 0.60 – 4.81) and vitamin D insufficiency (OR =2.13; 0.79 – 5.77).

Conclusion and recommendations

Vitamin D deficiency is highly prevalent among non-western immigrants compared to indigenous European populations. Vitamin D deficiency is particularly common in pregnant non-western immigrant women. Of the modifiable determinants, fatty fish and supplements were the greatest contributors to the serum 25(OH)D concentration in a multiethnic population. Unambiguous associations between low serum 25(OH)D concentrations and muscle-related outcomes were not found in the study described in this thesis. We did find an association between low serum 25(OH)D concentrations and diabetes mellitus, though this was not significant. Several studies found negative consequences of low serum 25(OH)D concentrations. Hence, general practitioners, midwives and other medical personnel should be alert on the possibility of vitamin D deficiency among non-western immigrants.

In the studies described in this thesis, the association between serum 25(OH)D concentration and consequences (muscle-related outcomes and diabetes mellitus) were studied in a cross-sectional design. Intervention studies are recommended to study the consequences of low serum 25(OH)D in non-western immigrants. In the case of pregnant women, the consequences include those in their offspring. The most effective strategy to raise serum 25(OH)D concentrations is not known. Comparative studies are recommended in which various strategies are used to reach the non-western immigrants and to increase their vitamin D intake, exposure to sunlight, or both. Furthermore, it is recommended to work on a validated questionnaire or other possible instruments to measure the real intake or exposure validly.