# Dietary Intake of Vitamins in Different Options of Treatment in Chronic Kidney Disease: Is There a Deficiency?

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ABSTRACT

Background. The importance of diet in the management of kidney transplantation (KT), as well as other treatment options of chronic kidney disease (CKD), is generally acknowledged. However, data regarding vitamin intake are very limited. Vitamins are essential in maintaining good nutritional status and preventing many chronic complications. It is still not clear which treatment modality imposes the highest risk of dietary vitamin deficiency and whether successful KT reverses such a threat.

Methods. We performed this observational study to assess dietary intake of vitamins in CKD patients: after successful KT, not yet dialyzed (ND), treated with hemodialysis (HD), and with peritoneal dialysis (PD). A total of 202 patients were recruited (45 KT, 50 ND, 45 HD, and 62 PD). Vitamin intakes were evaluated through the use of a 24-hour dietary recall and processed with the use of a computerized database. Each record was evaluated by a skilled dietitian. In general, vitamin intakes in all study groups were comparable, with KT and ND groups manifesting lower risk of deficiency than HD and PD groups.

Results. The content of fat-soluble vitamins in diet was insufficient, with remarkably high prevalence of vitamin D deficiency. Mean intakes of water-soluble vitamins were close to recommended, with the exception of folic acid, which was profoundly deficient in all groups.

Conclusions. CKD patients are at risk of inadequate vitamin intake. Vitamin D and folic acid are universally deficient in diet. KT patients have the most satisfactory content of vitamins in their diet, whereas HD individuals are at highest risk of deficiency.

MICRONUTRIENT deficiency, like other forms of malnutrition, may contribute to morbidity and mortality in chronic kidney disease (CKD). An increased risk for vitamin deficiency in CKD is multifactorial and includes loss of appetite, dietary restrictions, changed perception of taste, depressive mood, impaired gastrointestinal absorption, abnormal metabolism, dialysis-related losses, and concomitant medication. The knowledge about vitamin needs of CKD patients on dialysis is incomplete, and that of patients in earlier stages of the disease, or after successful kidney transplantation, is further limited [1,2]. Also, it remains to be elucidated whether supplementation of vitamins in pharmacological doses is beneficial and safe in CKD. It is debatable which, if any, vitamins are deficient in transplant recipients. Also, it is not established yet when exactly deficiency starts and what measures should be used to prevent it. Dietary intake is a potentially modifiable factor that may have a role in prevention of vitamin deficiency and in an improvement of the prognosis.

We performed this study to assess dietary intake of vitamins in CKD patients: after successful KT, treated with hemodialysis (HD), treated with peritoneal dialysis (PD),

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and not yet dialyzed (ND). The additional aims were to determine which option of renal replacement therapy (RRT) poses the greatest risk of the dietary deficiency and to indicate vitamins most prone to be deficient in diets of CKD patients.

## METHODS

The study was approved by the local ethics committee, and informed consent was obtained from all participants before enrollment. We enrolled a group of participants randomly chosen from a cohort of CKD patients who met inclusion criteria and were willing to participate in our project. Inclusion criteria were as follows: age >18 years, not receiving vitamin supplements, not taking medications influencing vitamin absorption or metabolism (eg, tuberculostatics, methotrexate, etc), physical and mental abilities to prepare meals and eat independently, lack of undercurrent illness (eg, neoplasm, acute infection, active rheumatoid disease, etc), satisfactory dialysis adequacy or graft function, and adequate dialysis (defined as latest KT/V >1.2 for HD and weekly KT/V >1.7 for PD). We excluded patients prior to the commencement of RRT from the CKD group and we excluded patients treated shorter than 3 months from HD and PD groups. KT recipients needed to have graft function stable for 3 consecutive months before inclusion.

Ten patients were excluded because of the difficulty in providing accurate diet recall. Ultimately, the study group consisted of 202 patients (45 KT recipients, 50 ND with stages G3-5 CKD, 45 HD patients, and 62 PD patients). In the ND group, 19 patients were in stage 3 of CKD, 25 in stage 4, and 5 in stage 5. In the KT group, 30 patients were in stage 3 of CKD, 8 in stage 4, and 7 in stage 5. The vitamin intakes were evaluated through the use of a 24-hour dietary recall and processed with the use of a computerized database. To ensure the accuracy of the recall, each record was evaluated by a skilled dietitian and patients were asked to provide additional information, if indicated. The estimated average requirement (EAR) was used as an indicator of an adequate intake, according to the current local dietary norms [3].

### Statistical Analysis

Categorical data are expressed as n values and percentages. Continuous data are expressed as mean ± standard deviation (SD) or medians and interquartile ranges, depending on the distribution. Categorical data were compared by use of a $\chi^2$ test. Analysis of variance or the Kruskal-Wallis test was used for between-group comparisons, depending on the distribution of the data. The relationship between vitamin intake and other nutrient content of diet was tested through the use of Spearman's correlation. The level of statistical significance was defined as $P < .05$.

## RESULTS

Characteristics of the groups are summarized in Table 1. The KT group had the highest protein and potassium content in diet as compared with other groups of patients (KT vs HD, $P = .008$; KT vs PD, $P = .004$). Mean total energy content in daily diet, intake of fats, and carbohydrates were not different between the groups.

Mean intake of vitamins and percentages of individuals with inadequate vitamin intake are shown in Table 2 and Fig 1. Dietary content of all vitamins correlated significantly with energy, protein, fat, and carbohydrate intake (data not shown).

All KT participants of the study and most of patients from the ND, HD, and PD groups (96%, 97.8%, and 98.3%, respectively) had lower than recommended intake of vitamin D. In general, fat-soluble vitamin intake was not different between groups and was insufficient in many cases. Only mean intake of vitamin A (expressed as retinol equivalents) differed significantly between HD and PD groups, being excessively high in PD participants, discordant with current recommendations for dialysis patients [4]. Also, intakes of water-soluble vitamins were comparable in all CKD groups with the exception of vitamin C and vitamin B2. The mean intake of vitamin C met requirements but was significantly lower in HD patients. Mean vitamin B2 intake was lowest in the PD group. All water-soluble vitamins, except for folic acid, were taken within recommended amounts, taking into account means for groups. However, on an individual level, a substantial percentage of patients in each group did not meet daily requirements for vitamins in their diet. In general, the lowest rate of insufficient intake was observed in the KT group and the highest in HD or PD groups. The ND group had intake lower than the KT group and higher than the dialyzed group. Folic acid was the most deficient water-soluble vitamin in daily diets. Mean intake of this vitamin was not sufficient in any of the studied groups, and a high proportion of participants had inadequate intake on the individual level (72%, 77.4%, 84.4%, and 91.6% for ND, KT, HD, and PD patients, respectively).

**Table 1. Characteristics of Study Participants**

| Variable | ND | KT | HD | PD |
|---|---|---|---|---|
| No. of participants | 50 | 45 | 45 | 62 |
| Age (years) | 66.4 ± 16.6 | 52.2 ± 15 | 56.9 ± 17.4 | 59.4 ± 14.0 |
| Male/female | 9/42 | 21/14 | 22/23 | 36/26 |
| Percentage of diabetics | 32 | 35.3 | 13.3 | 50 |
| Duration time of CKD (years) | 11.9 ± 16.7 | 7.8 ± 7.7 | 7.8 ± 7.4 | 16.9 ± 22.5 |
| BMI (kg/m$^2$) | 27.5 ± 5 | 27 ± 6.7 | 23.4 ± 4.68 | 25.4 ± 4.2 |
| Energy content of diet (kcal/kg BW) | 21.8 ± 11.3 | 24.2 ± 11.4 | 24.9 ± 13.7 | 19.7 ± 8.1 |
| Protein content of diet (g/kg BW) | 0.87 ± 0.44 | 1.07 ± 0.55 | 0.95 ± 0.45 | 0.70 ± 0.40 |
| Potassium content of diet (mg/24 h) | 2909 ± 1206 | 3305 ± 1384 | 2737 ± 1842 | 2398 ± 993 |

Categorical data are expressed as n values or percentages. Continuous data are expressed as mean ± SD.
Abbreviations: BMI, body mass index; BW, body weight.

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