nci

Original Article PUBLIC HEALTH

North Clin Istanb 2023;10(5):618–625
doi: 10.14744/nci.2023.42899

# Cost analysis of 25-hydroxy vitamin D tests in Turkiye with big data: A cross-sectional study

Mustafa Mahir Ulgu,[1] Murat Caglayan,[2] Naim Ata,[1] Cigdem Sonmez,[3] Mehmet Senes,[4] Ozlem Gulbahar,[5] Ataman Gonel,[6] Suayip Birinci[1]

[1]Ministry of Health, Ankara, Turkiye

[2]Department of Medical Biochemistry, Etlik City Hospital, Ankara, Turkiye

[3]Department of Medical Biochemistry, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkiye

[4]Department of Medical Biochemistry, Ankara Training and Research Hospital, Ankara, Turkiye

[5]Department of Medical Biochemistry, Gazi University Training and Research Hospital, Ankara, Turkiye

[6]Department of Nutrition and Dietetics, Hasan Kalyoncu University Faculty of Health Science, Gaziantep, Turkiye

## ABSTRACT

**OBJECTIVE:** The high prevalence of vitamin D deficiency in the population causes physicians to request more vitamin D tests and increases laboratory costs. It is aimed at investigating the demanded numbers and cost analyzes of 25-hydroxyvitamin D (25(OH)D) tests with the big data obtained from the national information health system of the Turkish Ministry of Health.

**METHODS:** Between 2017 and 2018, all inpatient and outpatient tests and 25(OH)D tests in all medical biochemistry laboratories in Turkiye were determined based on department and institution type. The cost amount, distribution among health institutions, and test request rates were calculated. In both years, the top ten most expensive tests, according to health institutions, were evaluated.

**RESULTS:** The total number of medical biochemistry tests performed in 2017 and 2018 was 1.424.948.155 and 1.713.134.326, respectively. The number of 25 (OH)D tests analyzed in the same years was 8.698.393 and 13.919.127, respectively. When the data of the 2 years are compared, the consumption of 25 (OH)D tests increased by 37% in General hospital laboratories, whereas it increased by 115.09% in primary health laboratories. When all health institutions were evaluated, the increase rate in 25 (OH)D test demand was 60%, while the cost increase rate was 23%.

**CONCLUSION:** This report showed that the demands for 25(OH)D testing are increasing steeply, especially in primary health-care facilities. In this direction, laboratory information system test demand restrictions in accordance with national and international guidelines are important issues for policymakers.

*Keywords: 25-hydroxyvitamin D; big data; biochemistry; clinical laboratory test; cost analysis; national health.*

***Cite this article as:*** *Ulgu MM, Caglayan M, Ata N, Sonmez C, Senes M, Gulbahar O, et al. Cost analysis of 25-hydroxy vitamin D tests in Turkiye with big data: A cross-sectional study. North Clin Istanb 2023;10(5):618–625.*

Health expenditures are generally accepted as expenditures made on all health screening, diagnosis, treatment, rehabilitation, primary care, and emergency services programs that adopt the aim of protecting and improving health [1]. The level of per capita health expenditures varies according to the development level of the countries and is correlated with the total amount of the country's budget in developed countries, according to official statistics [2]. The increase in health expenditures, especially in developed

*Received:* May 22, 2023 *Revised:* June 02, 2023 *Accepted:* July 07, 2023 *Online:* August 29, 2023

Correspondence: Mustafa Mahir ULGU, MD. Saglik Bakanligi, Ankara, Turkiye.
Tel: +90 312 471 80 05 e-mail: ulgumahir@gmail.com

countries, can be explained by the prolongation of life expectancy, chronic diseases, and the increase in hospitalization times in the last 40 years [3]. In addition, developments and innovations in medical technology and the increasing demands and expectations of people in the health-care sector can be counted among these reasons. The resources allocated in an effective health system are used to achieve the best health performance without increasing costs [4]. In recent years, the increase in the health expenditures of the countries has exceeded the growth of their general economies and seriously strains their budgets, so governments must deal with this inevitable situation [5].

In health-care services, medical laboratories have a critical role in the evaluation of the health status of the individual, with a diagnostic potential of 70% [6]. This potential can be more effective with technological innovations, newly detected biomarkers, and molecular developments. Besides the effectiveness and crucial role of the medical laboratories, the ratio of their expenditures to total health-care expenditures is approximately 5–10% [6]. In Turkiye, total health expenditure, which was $12.467.468.000 in 2002, increased to $39.662.184.539 in 2016. While spending on the purchase of medical laboratory services in 2002 was approximately $100 million (0.802% of the entire budget), in 2016 it increased approximately 3.5-fold, exceeding $350 million (~0.882% of the overall budget) [7]. Although the percentage of medical laboratory expenditures is decreasing nowadays, labs have to test at a lower cost without sacrificing quality. In order to reach the optimal cost without sacrificing high quality in health institutions, different purchasing models (goods purchase, service purchase) and cost analysis models are generally used. In 2016, medical laboratory service procurement rates for state, university, and private health institutions in Turkiye were 67%, 24%, and 9%, respectively [7]. To minimize costs, reasonable cost analysis evaluates the costs of medical laboratories by department, device, or test. The immunoassay group often has the highest cost rate, and the 25-hydroxyvitamin D (25(OH)D) test is one of the most striking tests of recent years; its demand and cost in this group are increasing uncontrollably day by day [8–11]. In this study, it was aimed to investigate the requested 25(OH)D test number and the cost among the laboratory expenditures according to the big data obtained from the Turkish Ministry of Health's national information health-care system.

**Highlight key points**

- 25(OH)D test is inappropriately used as a screening test around the world.
- In terms of cost, the first ten costliest tests were evaluated between 2017 and 2018, and the 25(OH)D test was found to be the second costliest test after CBC.
- Especially primary care physicians demand 25(OH)D test more and more day by day.

## MATERIALS AND METHODS

### Data Collection

"Transformation Program in Healthcare," one of Turkiye's primary health system reforms, was launched in 2005. This program has gathered all public health institutions, military hospitals, and municipal hospitals under the Ministry of Health. Health institutions are first divided into public health facilities, private health facilities, and university institutions. State health facilities are classified as primary healthcare institutions and general hospitals according to their capacities and service delivery areas. All health institutions have started to provide health-care services under the General Health Insurance System since 2006 [12].

E-Health uses information and communication technologies for health and includes the data of health information systems such as electronic health records, telemedicine, mobile devices, e-learning tools, and decision support systems [13, 14]. In Turkiye, for healthcare, insurance, and finance, the Social Security Institution (SSI) uses the Medulla program, which is integrated with the health-care institutions. The institutions affiliated with the Ministry of Health also use saglik.net e-health applications for medical records. The Medulla program can be defined as an integrated electronic system that transmits information electronically between SSI and health-care institutions for approval, billing, and reimbursement of health expenditures [15, 16]. For coding and pricing of health-care services, The Health Practice Price List (HPPL) provides a list of medical processes. In addition, all medical procedures based on this list are collected in a database (e-saglik) via the health web system [17].

### Study Design

The tests performed by the medical biochemical laboratories (clinical chemistry, immunochemistry, Complete blood count [CBC], coagulation, toxicology, urine analysis, erythrocyte sedimentation rate, metabolism, etc.) between 2017 and 2018 were evaluated on the basis of the requested test number, institution type, and cost analysis. HPPL was used for the cost analysis, and the total cost was calculated by multiplying the number of the requested tests by the HPPL price for each test [16]. The amount and distribution of costs and the test consumption between 2017 and 2018 were evaluated by comparing the rates among the health-care facilities. All inpatient and outpatient tests performed in the medical biochemistry laboratory were also evaluated according to the department, and the 25 (OH)D test was evaluated individually. The tests were listed by cost, and the ten costliest tests per year were evaluated. Turkish Ministry of Health gave permission for the data to be published (27.11.2019/ 95741342-020, permission date and number).

### Statistical Analysis

Study data was conveyed in the SPSS statistical package program (version 20.0; SPSS, Inc., Chicago, IL, USA) for analysis. Statistics were given as numbers and percentages.

## RESULTS

The total number of tests performed by medical biochemistry laboratories obtained through the electronic health system in 2017 and 2018 was 1.424.948.155 and 1.713.134.326, respectively. When these laboratories are evaluated on the basis of the department in these years, the cost rates calculated for both years are given in Table 1. The number of 25 (OH)D tests analyzed in the same years was 8.698.393 and 13.919.127, respectively (Table 2).

The number, cost, and increase rates of 25 (OH)D tests analyzed by health-care facility types in 2017–2018 are given in Table 2. When we evaluated government facilities individually in 2017 and 2018, 6.531.683 and 8.966.537 25 (OH)D tests were performed in general hospital laboratories, respectively (Table 2). However, primary health-care laboratories carried out 1.028.731 and 2.212.666 25 (OH)D tests for the same years, respectively.

As a result, the consumption of general hospital laboratory 25 (OH)D tests increased by 37%, while primary healthcare laboratory consumption steeply increased by 115.09%. When we evaluated public laboratories in terms of costs, the cost increase rate was 7.17% for general hospital laboratories and 61.32% for primary health laboratories.

TABLE 1. Cost rates for medical biochemistry laboratories based on departments in 2017–2018

| Departments | 2017 (%) | 2018 (%) |
|---|---|---|
| Clinical chemistry | 35.95 | 36.20 |
| Immunoassay | 34.54 | 36.09 |
| Complete blood count | 8.59 | 8.32 |
| Coagulation | 6.44 | 6.36 |
| Urine analysis | 4.64 | 4.39 |
| High pressure liquid chromatography | 2.03 | 2.04 |
| Blood gas | 1.95 | 2.34 |
| Toxicology | 1.57 | 1.57 |
| Trace elements | 1.33 | 0.13 |
| Point of care test | 0.81 | 0.65 |
| Erythrocyte sedimentation rate | 0.74 | 0.70 |
| Metabolism and Chromatography | 0.68 | 0.65 |
| Other | 0.34 | 0.16 |
| Electrophoresis | 0.23 | 0.23 |
| RIA | 0.10 | 0.10 |
| Gaita | 0.07 | 0.08 |

RIA: Radioimmunoassay.

TABLE 2. Number of 25(OH)D tests and cost and increase rates between 2017 and 2018 by health institution type

| | Test number | | | Cost (TL) | | |
|---|---|---|---|---|---|---|
| | Test number | | | Total Cost | | |
| | 2017 | 2018 | Rise rate (%) | 2017 | 2018 | Rise rate (%) |
| Government Health-care facilities | 6.531.683 | 8.966.537 | 37 | 166.557.917 | 171.485.020 | 3 |
| Private health-care facilities | 1.191.043 | 1.848.735 | 55 | 30.371.597 | 35.357.057 | 16 |
| University health-care facilities | 975.667 | 1.409.474 | 44 | 24.879.509 | 26.956.190 | 8 |
| Total | 8.698.393 | 13.919.127 | 60 | 221.809.020 | 273.366.954 | 23 |

The top-ten costliest tests evaluated according to the health-care facilities, the number of requested tests, and the cost rates within biochemistry laboratory tests for the years 2017 and 2018 are given in Table 3. When we evaluated tests individually, the consumption rates of the 25 (OH)D test were 0.68% (Rank 42$^{nd}$), and 0.84% (Rank 40$^{th}$), while the cost ratios were 6.88% and 6.72% for 2017 and 2018.

The ten costliest tests were evaluated; while 25(OH)D, urine analysis, TSH, PT, and creatinine tests were the same in all health institutions, Vitamin B12 and free T4 tests were in both public and private healthcare facilities. Ferritin and Troponin I tests were only in public health institutions; CRP and ALT tests were in private healthcare institutions; and PT, procalcitonin, blood gas analysis, and blood urea tests were in university healthcare institutions (Table 3). The top ten costliest tests were evaluated in primary health care facilities between 2017 and 2018; while CBC, 25(OH)D, Vitamin B12, TSH, Free T4, Free T3, Ferritin, LDL cholesterol, and HbA1c test were the same, the 1,25-Dihydroxy Vitamin D test in 2017 and the folic acid test in 2018 were on the list. The 25(OH)D test was second in 2017 but was the most expensive test in 2018 (Table 4). The costliest top ten tests did not differ between years. The order of the tests also did not change between the 2 years, except for the PT and Vitamin B12 tests (Table 5).

## DISCUSSION

In the study, the increase in test consumption in medical biochemistry laboratories was 20%, and the rate of increase in cost was 14.20% in 2-year periods. The rate of increase in health services expenditures in Turkiye between 2010 and 2018 was 268%, and it is noteworthy that this increase accelerated significantly after 2012. Especially in 2017 and 2018, the increase in all health service expenditures was 17.48%, while the increase in laboratory test costs was less [7]. Laboratory expenditures on the basis of departments did not change much between the 2 years; it was observed that the most demanded and costly department was clinical chemistry, and the second test department was the immunoassay group. In a study by Mouseli et al. [8], laboratory expenditures were classified as direct (reagents and human resources) and indirect (water and electricity supply, etc.), and the largest expenditures among direct costs were in the immunochemistry group (23.03%) and the clinical chemistry group 20.84%. In a study covering the years 2006–2009 in Taiwan, it was shown that clinical chemistry had the highest rate of direct expenditure, seroimmunology tests were the second group, and hematological tests were the third group, and these results are similar to the results of our study [18]. When the tests are evaluated individually, in another study conducted in Australia, CBC was the most requested and costly test between 2000 and 2010. This study also showed that 25(OH)D testing expenses increased by 59% from 1.02 million to 96.7 million over a 10-year period [19]. We also determined that the demand growth rate for the 25(OH)D test was 60%, the test cost increased 23% in the 2-year period, and both were above the total laboratory consumption and costs. The discordance between the consumption rate and cost rate between the 2 years was related to the 30% decrease in HPPL test price after June 2018.

In recent years, interest in Vitamin D has increased both in the world and in our country, due to reasons such as revealing its relationship with diseases, increasing scientific publications, and the influence of the media. In a study conducted in 2008, it was emphasized that the demand for any laboratory test did not increase by 80–90%, as in 25(OH)D [20]. In another study conducted by Bilinski and Boyages (women aged 45–74 years) between 2001 and 2011, the number of 25(OH)D tests and the number of bone densitometers were compared, and it was shown that there was a significant increase in 25(OH)D test requests compared to the number of bone densitometers [21]. In our study, the number of laboratory test requests and the inconsistent increase rate of 25(OH)D test demand over the 2-year period are similar to the results published in the literature in recent years [20, 21].

There are studies showing that the 25 (OH)D test is unnecessarily requested by primary care physicians around the world as a screening test independent of clinical diagnosis or pre-diagnosis. In the UK, Basatemur et al. [22] evaluated 772.525 25 (OH)D levels of healthy children (1–17 years old) requested by 156 family physicians between 2000 and 2014, reporting an increase in both test demand and prescriptions. They showed that this increase was more pronounced, especially after 2008, and was 15 times greater between 2008 and 2013. In another study, comparing the numbers of 25 (OH) D tests in 2006–2007 and 2012–2013, Rodd et al. [23] showed that the number of tests performed increased from 4,854 to 20,089, and they emphasized that family physicians were responsible for this trend. In addition, a study conducted in the UK showed that the demand for

**Table 3.** The top ten most costly tests according to health institutions in 2017–2018

| Government health-care facilities | | | | Private health-care facilities | | | | University health-care facilities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Test name | Test number 2017 | Total cost 2017 | Cost rate (%) 2017 | Test name | Test number 2017 | Total cost 2017 | Cost rate (%) 2017 | Test name | Test number 2017 | Total cost 2017 | Cost rate (%) 2017 |
| CBC | 66.087.848 | 198.263.544 | 7.2 | CBC | 17.909.183 | 53.727.549 | 12.6 | CBC | 9.526.420 | 28.579.260 | 7.11 |
| 25-OH-D | 6.531.683 | 166.557.917 | 6. | 25-OH-D | 1.191.043 | 30.371.597 | 7.1 | 25-OH-D | 975.667 | 24.879.509 | 6.19 |
| Urine analysis | 22.084.271 | 110.421.355 | 4 | Urine analysis | 5.528.110 | 26.747.717 | 6.3 | Urine analysis | 3.175.267 | 15.876.335 | 3.95 |
| Thyroid stimulating hormone (TSH) | 22.463.894 | 101.087.523 | 3.7 | Thyroid stimulating hormone (TSH) | 4.114.361 | 18.514.625 | 4.3 | Prothrombin time (PT) | 2.599.214 | 15.595.284 | 3.88 |
| Prothrombin time (PT) | 12.890.342 | 77.342.052 | 2.8 | CRP | 6.925.959 | 17.314.898 | 4.1 | Active prothrombin time (aPTT) | 2.298.576 | 12.412.310 | 3.09 |
| Vitamin B12 | 15.257.282 | 76.286.410 | 2.8 | Prothrombin time (PT) | 2.321.811 | 13.930.866 | 3.3 | Thyroid stimulating hormone (TSH) | 2.300.842 | 10.353.789 | 2.57 |
| Free thyroxine (free T4) | 15.325.146 | 68.963.157 | 2.5 | Vitamin B12 | 2.541.380 | 12.706.900 | 3 | Procalcitonin | 319.809 | 8.155.130 | 2.03 |
| Creatinine | 57.062.403 | 62.768.643 | 2.3 | Creatinine | 9.947.124 | 10.941.836 | 2.6 | Blood gas | 1.839.360 | 9.380.736 | 2.33 |
| Troponin I | 6.848.821 | 61.639.389 | 2.2 | Alanine aminotransferase (ALT) | 8.974.546 | 9.872.001 | 2.3 | Creatinine | 8.441.380 | 9.285.518 | 2.31 |
| Ferritin | 11.707.841 | 58.539.205 | 2.1 | Free T4 | 2.168.501 | 9.758.255 | 2.3 | Urea | 8.230.555 | 9.053.611 | 2.25 |
| Test name | Test number 2018 | Total cost 2018 | Cost rate (%) 2018 | Test name | Test number 2018 | Total cost 2018 | Cost rate (%) 2018 | Test name | Test number 2018 | Total Cost 2018 | Cost rate (%) 2018 |
| CBC | 72.216.232 | 205.816.261 | 6.7 | CBC | 21.929.001 | 62.497.653 | 11.6 | CBC | 12.311.636 | 35.088.163 | 6.9 |
| 25-OH-D | 8.966.537 | 171.485.020 | 5.6 | 25-OH-D | 1.848.735 | 35.357.057 | 6.6 | 25-OH-D | 1.409.474 | 26.956.190 | 5.3 |
| Urine analysis | 23.919.969 | 113.619.853 | 3.7 | Urine analysis | 5.528.110 | 26.747.717 | 5 | Urine analysis | 4.014.930 | 19.070.918 | 3.7 |

**Table 3 (Cont).** The top ten most costly tests according to health institutions in 2017–2018

| Government health-care facilities | | | | Private health-care facilities | | | | University health-care facilities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Test name | Test number 2018 | Total cost 2018 | Cost rate (%) 2018 | Test name | Test number 2018 | Total cost 2018 | Cost rate (%) 2018 | Test name | Test number 2018 | Total Cost 2018 | Cost rate (%) 2018 |
| Thyroid stimulating hormone (TSH) | 24.865.014 | 106.297.935 | 3.5 | Thyroid stimulating hormone (TSH) | 5.559.301 | 23.766.012 | 4.4 | Prothrombin time (PT) | 3.330.606 | 18.984.454 | 3.7 |
| Vitamin B12 | 17.679.648 | 83.978.328 | 2.8 | CRP | 9.999.352 | 23.748.461 | 4.4 | APTT | 3.019.790 | 15.491.523 | 3.0 |
| Prothrombin time (PT) | 14.254.901 | 81.252.936 | 2.7 | Prothrombin time (PT) | 3.055.672 | 17.417.330 | 3.2 | Procalcitonin | 606.363 | 14.689.144 | 2.9 |
| Free thyroxine (Free T4) | 17.098.638 | 73.096.677 | 2.4 | Vitamin B12 | 3.602.809 | 17.113.343 | 3.2 | Thyroid stimulating hormone (TSH) | 2.977.266 | 12.727.812 | 2.5 |
| Troponin I | 8.030.817 | 68.663.485 | 2.3 | Creatinine | 13.569.076 | 14.179.684 | 2.6 | Blood gas | 2.581.212 | 12.505.972 | 2.5 |
| Creatinine | 65.385.669 | 68.328.024 | 2.3 | Alanine aminotransferase (ALT) | 14.179.684 | 12.962.578 | 2.4 | Creatinine | 11.653.034 | 12.177.421 | 2.4 |
| Ferritin | 13.933.061 | 66.182.040 | 2.2 | Free T4 | 2.980.915 | 12.743.412 | 2.4 | Kan Üre Azotu | 10.762.822 | 11.247.149 | 2.2 |

25-OH-D: 25-hydroxy vitamin D; CBC: Complete blood count; Free T4: Free thyroxine; CRP: C-reactive protein.

**Table 4.** Top ten most costly tests in primary health care laboratories in 2017–2018

| Test name | Test number 2017 | Cost rate (%) 2017 | Test number 2018 | Cost rate (%) 2018 |
|---|---|---|---|---|
| CBC | 9.789.749 | 10.9 | 13.805.890 | 10.4 |
| 25-OH-D | 1.028.731 | 9.7 | 2.212.666 | 11.2 |
| Vitamin B12 | 3.200.523 | 5.9 | 5.175.920 | 6.5 |
| TSH | 3.464.615 | 5.8 | 5.335.789 | 6.0 |
| Free T4 | 2.831.497 | 4.7 | 4.286.361 | 4.8 |
| Ferritin | 2.347.566 | 4.3 | 3.910.135 | 4.9 |
| Free T3 | 2.198.440 | 3.7 | 3.111.952 | 3.5 |
| LDL cholesterol | 3.404.472 | 3.2 | 5.043.268 | 3.2 |
| (Hb A1C) HPLC | 443.670 | 2.8 | 579.511 | 2.5 |
| 1.25-Dihydroxy vitamin D | 287.479 | 2.7 | | |
| Folate | | | 1.704.919 | 2.8 |

CBC: Complete blood count; 25-OH-D: 25-hydroxy Vitamin D; TSH: Thyroid stimulating hormone; Free T4: Free thyroxine; Free T3: Free triiodothyronine; LDL cholesterol: Low-density lipoprotein cholesterol; Hb A1C: Hemoglobin A1c; HPLC: High-performance liquid chromatography.

**Table 5.** Top ten most costly tests in general hospital laboratories in 2017–2018

| Test name | Test number 2017 | Cost rate (%) 2017 | Test number 2018 | Cost rate (%) 2018 |
|---|---|---|---|---|
| CBC | 64.817.872 | 7.81 | 70.793.605 | 7.56 |
| 25-OH-D | 6.485.066 | 6.64 | 8.914.500 | 6.39 |
| Urine analysis | 21.960.963 | 4.41 | 23.804.760 | 4.24 |
| TSH | 22.275.395 | 4.03 | 24.631.594 | 3.95 |
| Vitamin B12 | 15.098.533 | 3.03 | 17.485.067 | 3.11 |
| PT | 12.841.072 | 3.09 | 14.198.685 | 3.03 |
| Free T4 | 15.181.154 | 2.74 | 16.929.050 | 2.71 |
| Creatinine | 56.249.392 | 2.49 | 64.442.254 | 2.52 |
| Troponin I | 6.609.392 | 2.39 | 7.729.208 | 2.48 |
| Ferritin | 11.574.090 | 2.32 | 13.757.821 | 0.52 |

CBC: Complete blood count; 25-OH-D: 25-hydroxy vitamin D; TSH: Thyroid stimulating hormone; PT: Prothrombin time; Free T4: Free thyroxine.

25 (OH)D tests in family medicine increased 11 times [24]. Bilinski et al. [9] also stated that the demand for 25 (OH)D tests increased 94 times between 2000 and 2010 and emphasized that this increase was mainly due to family physicians. In our study, the increase in demand for the 25 (OH)D test according to the type of institution did not show a significant difference in the 2-year period. Similar to other studies, a large mismatch was observed between general hospital laboratories and primary care laboratories in government-owned health-care facilities. Although the demand for 25 (OH)D testing increased by 7.17% in general hospital laboratories, the rate of increase in primary care laboratories is as high as 61.32%. This dissonant increase in vitamin D tests may be related to increased public interest in media influence, the demonstration of vitamin D's association with chronic disease, and the inclusion of the test in the primary health laboratory panel in recent years.

Recent studies show that unnecessary, inappropriate, and uncontrolled test requests in medical laboratories adversely affect healthy individuals and may lead to harmful treatments [25–27]. Measuring 25(OH)D concentrations is a good example and is not recommended as a routine screening test. As a result of this report, unless there is a definite indication, test requests from primary health-care institutions are unnecessary, and inappropriate, and far from evidence-based medicine. Currently, there is no consensus on testing and frequency for the diagnosis of 25 (OH)D deficiency. The Bone and Mineral Society of Australia, the American Society of Endocrinology and the Society of Endocrinology, and Metabolism of Turkiye do not recommend routine screening of the population for 25 (OH)D testing. However, it is recommended to screen only those at high risk of deficiency.

Our study has some limitations: the study only included 2-year results, the 25(OH)D method of measurement was not specified, clinical correlations were not evaluated, prescription rates and cost were not evaluated, repeated testing was not evaluated, HPPL cost analysis was performed only, the purchase price of the test was not evaluated, and the profitability was not calculated. Further studies addressing these will further elucidate the issue.

## Conclusion

In order to prevent unnecessary and inappropriate test requests, it will be beneficial for health managers and policymakers to evaluate the demanding clinics and the test demand according to clinical correlation and time interval. Accordingly, laboratory information systems test demand constraints in line with national and international guidelines, SSI policies, and HPPL price management are important issues to support evidence-based medicine and health management. In addition, it may be beneficial to conduct test analyzes with more sophisticated systems and develop new health policies that will reduce the number of unnecessary tests with artificial intelligence programs in order to prevent the health costs of the increasing population in the future.

**Ethics Committee Approval:** Approval was obtained from the Ministry of Health of Türkiye with an informed consent waiver for retrospective data analysis (date: 27.11.2019, number: 95741342-020).

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Authorship Contributions:** Concept – MMU, MC, NA; Design – MMU, CS, NA; Supervision – MMU, NA, MC; Data collection and/or processing – SB; Analysis and/or interpretation – CS, MS, OG; Literature review – NA, SB, MMU; Writing – MC, MMU, AG; Critical review – OG.

## REFERENCES

1. Bennett A, Garcia E, Schulze M, Bailey M, Doyle K, Finn W, et al. Building a laboratory workforce to meet the future: ASCP Task Force on the Laboratory Professionals Workforce. Am J Clin Pathol 2014;141:154–67.
2. Hüseyin A, Tıraş HH. Evaluation of health expenditures species in Turkey. [Article in Turkish]. KSÜSBD 2018; 15:643–70.
3. Waise A, Plebani M. Which surrogate marker can be used to assess the effectiveness of the laboratory and its contribution to clinical outcome? Ann Clin Biochem 2001;38:589–95.
4. Palmer S, Torgerson DJ. Economic notes: definitions of efficiency. BMJ 1999;318:1136.
5. PricewaterhouseCoopers. HealthCast 2020: Creating a Sustainable Future. Available at: https://commed.vcu.edu/IntroPH/policy/healthcast2020.pdf. Accessed Jul 19, 2023.
6. Forsman RW. Why is the laboratory an afterthought for managed care organizations? Clin Chem 1996;42:813–6.
7. Atasever M, Altınkaynak K. Sağlık İşletmelerinde Tıbbi Laboratuvar Hizmet Alımları Yönetimi. Ankara: Mehmet Atasever; 2017.
8. Mouseli A, Barouni M, Amiresmaili M, Samiee SM, Vali L. Measuring the net profit of laboratory services: a case study in Iran. Med J Islam Repub Iran 2018;32:12.
9. Bilinski K, Boyages S. Evidence of overtesting for vitamin D in Australia: an analysis of 4.5 years of Medicare Benefits Schedule (MBS) data. BMJ Open 2013; 3:e002955.
10. Boyages S, Bilinski K. Seasonal reduction in vitamin D level persists into spring in NSW Australia: implications for monitoring and replacement therapy. Clin Endocrinol (Oxf) 2012;77:515–23.
11. Singh RJ. Are clinical laboratories prepared for accurate testing of 25-hydroxy vitamin D? Clin Chem 2008;54:221–3.
12. Atasever M, Karaca Z, Uçar E. Türkiye Sağlık Hizmet Alımları Rehberi: (Yönetim, Mevzuat, Tedarik, Uygulama, Muhasebe, Harcama Rakamları ve Analiz). Ankara: Mehmet Atasever; 2017.
13. WHO. Using e-health and information technology to improve health. Available at: https://www.who.int/westernpacific/activities/using-e-health-and-information-technology-to-improve-health. Accessed Jul 19, 2023.
14. Gerber T, Olazabal V, Brown K, Pablos-Mendez A. An agenda for action on global e-health. Health Aff (Millwood) 2010;29:233–6.
15. Par ÖE, Soysal E. Comparison of standards and acts used in Medula with HIPAA in terms of security of personal health records. [Article in Turkish]. Medical Informatics Association (MIA). VIII. National Medical Informatics Congress; 2011 Nov 17-20; Antalya. p. 82–7.
16. Birinci Ş. A Digital opportunity for patients to manage their health: Turkey national personal health record system (the e-Nabız). Balkan Med J 2023;40:215–21.
17. T.C. Sağlık Bakanlığı. E-nabız: Kişisel Sağlık Sistemi. Available at: https://e-saglik.gov.tr/. Accessed Jul 19, 2023.
18. Su BG, Chen SF, Yeh SH, Shih PW, Lin CC. Cost evaluation of clinical laboratory in Taiwan's National Health System by using activity-based costing. Clin Chem Lab Med 2016;54;1753–8.
19. Bilinski KL, Boyages SC. The rising cost of vitamin D testing in Australia: time to establish guidelines for testing. Med J Aust 2012;197:90.
20. Woodford HJ, Barrett S, Pattman S. Vitamin D: too much testing and treating? Clin Med 2018;18:196–200.
21. Bilinski K, Boyages S. The vitamin D paradox: bone density testing in females aged 45 to 74 did not increase over a ten-year period despite a marked increase in testing for vitamin D. J Endocrinol Invest 2013;36:914–22.
22. Basatemur E, Hunter R, Horsfall L, Sutcliffe A, Rait G. Costs of vitamin D testing and prescribing among children in primary care. Eur J Pediatr 2017;176:1405–9.
23. Rodd C, Sokoro A, Lix LM, Thorlacius L, Moffatt M, Slater J, et al. Increased rates of 25-hydroxy vitamin D testing: dissecting a modern epidemic. Clin Biochem 2018;59:56–61.
24. Zhao S, Gardner K, Taylor W, Marks E, Goodson N. Vitamin D assessment in primary care: changing patterns of testing. London J Prim Care (Abingdon) 2015;7:15–22.
25. Sarafin K, Durazo-Arvizu R, Tian L, Phinney KW, Tai S, Camara JE, et al. Standardizing 25-hydroxyvitamin D values from the Canadian Health Measures Survey. Am J Clin Nutr 2015;102:1044–50.
26. Gonel A, Yetisgin A. False negative D vitamin measurement in LC-MS/MS method due to hyperlipidemia: case report. Comb Chem High Throughput Screen 2019;22:428–30.
27. Gonel A, Kirhan I, Koyuncu I, Bayraktar N, Karadag ME, Karadag M. The role of interferences in the increasing incidence of vitamin D deficiency. Endocr Metab Immune Disord Drug 2020;20:1303–8.