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Research Article

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UNNECESSARY LABORATORY TEST REPETITION IN PRIMARY HEALTHCARE ORGANIZATIONS

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Abstract

Objectives: Laboratory tests are an important tool in reaching the right medical diagnosis and have become an indispensable element for physicians. In this study, we aimed to determine the frequency of unnecessary laboratory test use in primary healthcare institutions, the effect of this situation on health expenditures, and the increase in laboratory test use.

Materials and Methods: In our study, the data of 25 specific tests studied between 2016 and 2019 in Konya Public Health Laboratory, which serves primary healthcare institutions, were examined. The compliance of these tests with the minimum test repetition interval was retrospectively screened, and the frequency of unnecessary test requests was determined.

Results: A total of 15,425,622 laboratory tests were evaluated in the study. Of these, 11,541,394 (74.8%) were performed on women, and 13,289,770 (86.1%) were conducted on patients under 65 years of age. It was determined that 956,112 (6.2%) of the evaluated tests were unnecessary repetitions. Unnecessary test repetitions were found to be significantly higher in females compared to males ($p<0.001$) and in those above 65 years of age compared to those under 65 years of age ($p<0.001$). The 4-year cost of unnecessary laboratory tests was determined to be ₺5,479,093.37. It was also found that the use of laboratory tests increased by 123.6% over the 4-year evaluation period.

Conclusion: The use of laboratory tests in primary care is increasing and unnecessary repeated tests harm the country's economy. To reduce costs and provide better health care, it is necessary to use laboratory tests wisely and to make effective interventions for this purpose.

Keywords: Primary healthcare services, unnecessary laboratory test repetition, health expenditures.

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Introduction

Today, the use of laboratory tests, which have become indispensable for physicians, is increasing rapidly.[1] There are great differences in the frequency of laboratory test requests by physicians, and these differences were not related to physicians' clinical competencies.[2,3] This unexplained difference in the frequency of laboratory test requests brings to mind the question of whether laboratory test orders are appropriate.

Unnecessary requests for laboratory tests will lead to a false-positive test result and an adventure of seeking treatment with a misdiagnosis of the patient. In addition, unnecessary requests are harmful not only to the patient but also to the country's economy due to the economic burden it creates on the health system.[4] Although laboratory test expenditures constitute a very small part of total health expenditures, it has been determined that laboratory tests affect 66% of the clinical decision-making process.[5] With these effects, laboratory tests indirectly affect a larger portion of health expenditures.

In the literature, different definitions have been used in many studies for the appropriateness of laboratory use, and the terms “unnecessary” and “inappropriate” are frequently used interchangeably. Unnecessary and inappropriate laboratory use is generally defined as a test request that falls outside of an approved guideline.[5]

Unnecessary repetition of laboratory tests is a subgroup of overuse of laboratory tests and is a subject that requires investigation in our country as well as in the rest of the world. Unnecessary laboratory test repetition can also be defined as tests that do not comply with the minimum test request time intervals given in approved guidelines.[6]

Due to the high number of them, it was seen that primary care physicians had more laboratory test requests than other specialties and 58% of laboratory test expenditures belonged to primary care physicians.[7] Diagnosing in primary care is a complex process. Situations such as the specific clinic have not yet been evident, the vagueness of the complaints, and the overlapping of non-dangerous and serious symptoms make it difficult to reach the diagnosis.[8] This difficult process in reaching the diagnosis may cause family physicians to prefer laboratory test orders more than normal.

Factors such as lack of experience, fear of lawsuits, unawareness of the cost of the tests, patient pressure (patients insistently demanding tests), lack of accessible guidelines, fear of making mistakes, development of modern diagnostic technologies, and rapid access to test results take place in the increase in unnecessary laboratory test requests.[9]

This study aims to determine the frequency of unnecessary laboratory test use in primary healthcare institutions and to assess the impact of this practice on healthcare expenditures and the overall increase in laboratory test utilization.

Materials and Methods

In this study, 25 laboratory tests (alanine aminotransferase (ALT), aspartate aminotransferase (AST), high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, triglyceride, total cholesterol, hemoglobin A1c (HbA1c), uric acid, vitamin B12, vitamin D, iron, ferritin, folate, thyroid stimulating hormone (TSH), free triiodothyronine (fT3), free thyroxine (fT4), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estradiol, total testosterone, progesterone, prolactin, total prostate-specific antigen (tPSA), rheumatoid factor (RF), antistreptolysin-O (ASO)) ordered in Konya Primary Healthcare Institutions and studied in Konya Public Health Laboratory during the 4 years between 01.01.2016-01.01.2020 were evaluated.

Out of a total of 15,486,427 laboratory test data obtained from the Konya Public Health Laboratory database, 60,805 (0.39%) with uncertain records in the system and incomplete or conflicting records of age and gender were excluded from this study.

In the obtained data, minimum test request time intervals specific to each test were used according to objective criteria to determine unnecessary laboratory test repetitions (Table 1).[10,11] Tests requested in a shorter time than the minimum test request time interval were considered unnecessary test repetitions. The total cost of unnecessary laboratory test repetitions was noted in TL (Turkish liras= ₺) using the number of unnecessary test repetitions of the determined tests and the current unit costs in the Health Implementation Communiqué (SUT) published in the Official Gazette No. 28597 dated March 24, 2013.[12]

Statistical Analysis of Study Data

In the study, descriptive analyses of categorical data are shown with frequency and percentage values, and descriptive statistics of numerical data are shown with mean ± standard deviation values. The normality assumption of the groups in the study was evaluated with the Shapiro-Wilk Test and the Kolmogorov-Smirnov Test. The Chi-squared test was used for the comparison of categorical data. 5% was accepted as the statistical significance limit in the study. All statistical analyses were performed using SPSS 22.0 (IBM Inc., Armonk, NY, USA) software.

Results

The evaluated 15,425,622 laboratory tests belong to 756,544 different patients and contain 25 different parameters. Of the 15,425,622 laboratory tests studied, 11,541,394 (74.82%) were requested from women and 3,884,228 (25.18%) from men. 13,289,770 (86.15%) of the tests were studied in patients under 65 years of age, and 2,135,852 (13.85%) in patients over 65 years of age. Of the 15,425,622 laboratory tests examined, 956,112 (6.2%) were considered unnecessary test repetitions. Unnecessary retest orders were significantly higher in females (6.6%) than males (5.0%) ($p<0.001$), and in patients over 65 years of age (6.9%) than in patients younger than 65 years old (6.1%) ($p<0.001$) (Table 2). The test with the highest rate of unnecessary test repetitions was found to be vitamin B12 (32.5%), and the lowest test was the uric acid (0.1%) test.

Table 1. Minimum test request time intervals

Test	Minimum request time interval	Reference
ALT	30 days	(11)
AST	30 days	(11)
HDL cholesterol	90 days	(11)
LDL cholesterol	90 days	(11)
Triglyceride	90 days	(11)
Cholesterol	90 days	(11)
HbA1c	60 days	(10)
Uric acid	3 days	(10)
Vitamin B12	365 days	(10)
Vitamin D	90 days	(10)
Iron	14 days	(10)
Ferritin	28 days	(10)
Folate	365 days	(10)
TSH	13 days	(10)
fT3	13 days	(10)
fT4	13 days	(10)
FSH	13 days	(10)
LH	13 days	(10)
Estradiol	13 days	(10)
Total testosterone	13 days	(10)
Progesterone	28 days	(10)
Prolactin	13 days	(10)
tPSA	28 days	(10)
RF	30 days	(10)
ASO	14 days	(11)

Table 2. Association of unnecessary test repetitions with gender and age

		Unnecessary Test Repetition n (%)	Appropriate Test n (%)	p
Gender	**Female**	760,173 (6.6%)	10,781,221 (93.4%)	<0.001
	Male	195,939 (5.0%)	3,688,289 (95.0%)	
Age	**Under 65 years old**	808,933 (6.1%)	12,480,837 (93.9%)	<0.001
	Over 65 years old	147,179 (6.9%)	1,988,673 (93.1%)	

The total cost of unnecessary test repetitions in the 4 years was detected as ₺5,479,093.37. Based on the tests, the test with the highest unnecessary retest cost was vitamin B12 (₺2,117,731.60), while the lowest test was total testosterone (₺428.86). Among the evaluated laboratory tests, the number of requests for each test, the number of unnecessary test repetitions, the unnecessary test repetition rate, and the unnecessary test repetition costs are given in Table 3.

Table 3: Numbers, frequency, and the cost of unnecessary test repetitions

Test	Total Number of Tests Evaluated	Number of Unnecessary Test Repetitions	Unnecessary Test Repetition Rate	Current Unit Cost (₺)	Total Cost (₺)	Estimated cost per year (₺)
ALT	1,098,458	17,812	1,6%	₺1.15	₺20,48	₺5120.95
AST	1,024,618	16,865	1,6%	₺1.05	₺17,70	₺4427.06
HDL	1,016,420	70,153	6,9%	₺1.67	₺117,1	₺29,288.88
LDL	990,773	66,689	6,7%	₺2.61	₺174,0	₺43,514.57
Triglyceride	1,032,509	71,663	6,9%	₺1.25	₺89,57	₺22,394.69
Cholesterol	1,039,734	72,310	6,9%	₺1.15	₺83,15	₺20,789.12
HbA1c	586,435	21,768	3,7%	₺17.77	₺386,8	₺96,704.34
Uric acid	608,352	577	0,1%	₺1.15	₺663.5	₺165.89
Vitamin B12	1,244,230	404,920	32,5%	₺5.23	₺2,117,	₺529,432.90
Vitamin D	1,013,723	77,230	7,6%	₺21.04	₺1,624,	₺406,229.80
Iron	832,381	3463	0,4%	₺1.15	₺3982.	₺995.61
Ferritin	938,748	9878	1,1%	₺5.23	₺51,66	₺12,915.48
Folate	421,983	104,584	24,8%	₺6.79	₺710,1	₺177,531.34
TSH	1,187,843	5086	0,4%	₺4.70	₺23,90	₺5976.05
fT3	661,651	2652	0,4%	₺4.70	₺12,46	₺3116.1
fT4	829,221	3211	0,4%	₺4.70	₺15,09	₺3772.92
FSH	51,101	297	0,6%	₺6.27	₺1862.	₺465.55
LH	43,385	255	0,6%	₺6.27	₺1598.	₺399.71
Estradiol	41,204	297	0,7%	₺6.27	₺1862.	₺465.55
Total	14,549	82	0,6%	₺5.23	₺428.8	₺107.21
Progesterone	30,699	648	2,1%	₺7.32	₺4743.	₺1185.84
Prolactin	44,776	328	0,7%	₺7.32	₺2400.	₺600.24
tPSA	72,888	657	0,9%	₺6.79	₺4461.	₺1115.26
RF	304,395	3319	1,1%	₺2.61	₺8662.	₺2165.65
ASO	295,546	1368	0,5%	₺2.61	₺3570.	₺892.62
TOTAL	**15,425,622**	**956,112**	**6,2%**		**₺5,479,**	**₺1,369,773.34**

It was determined that there was an increase in the use of laboratory tests every year (Figure 1). There was a significant increase of 123.6% in the use of 25 laboratory tests evaluated between 2016 and 2019. The test with the highest increase rate among laboratory tests was the vitamin D test and the rate of increase in 4 years was determined as 193.1%. The distribution of the evaluated tests by year and their 4-year increase rates are given in Table 4.

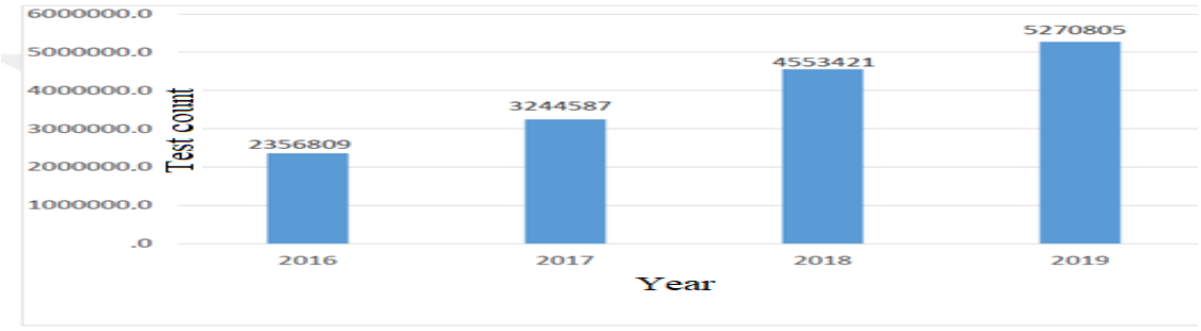

Figure 1. Number of requests for laboratory tests by years

Table 4. Annual request numbers and 4-year increase rates of laboratory tests

Test	2016	2017	2018	2019	4-year rate of increase
ALT	161,281	226,396	324,280	386,501	139.6%
AST	153,554	213,331	300,181	357,552	132.9%
HDL cholesterol	158,094	212,129	294,793	351,404	122.3%
LDL cholesterol	149,501	208,857	290,807	341,608	128.5%
Triglyceride	159,550	215,175	299,106	358,678	124.8%
Cholesterol	161,756	216,560	300,835	360,583	122.9%
HbA1c	87,858	123,750	181,419	193,408	120.1%
Uric acid	79,041	120,924	185,694	222,693	181.7%
Vitamin B12	197,275	262,721	365,185	419,049	112.4%
Vitamin D	124,873	207,910	314,968	365,972	193.1%
Iron	128,667	176,741	248,382	278,591	116.5%
Ferritin	142,606	195,074	277,236	323,832	127.1%
Folate	64,039	89,251	125,714	142,979	123.3%
TSH	181,540	246,581	347,807	411,915	126.9%
fT3	111,231	143,478	191,890	215,052	93.3%
fT4	133,427	177,247	241,023	277,524	107.9%
FSH	9030	12,093	14,597	15,381	70.3%
LH	7896	10,309	12,560	12,620	59.8%
Estradiol	7316	9610	11,794	12,484	70.6%
Total testosterone	2119	3248	4774	4408	108.0%
Progesterone	5664	7382	9218	8435	48.9%
Prolactin	7948	10,652	13,236	12,940	62.8%
tPSA	12,303	15,511	21,739	23,335	89.7%
RF	54,264	68,006	89,288	92,837	71.1%
ASO	55,976	71,651	86,895	81,024	44.7%

Discussion

In the literature, studies are showing that unnecessary laboratory tests are between 5.0% - 95.0%.[13-15] In a Canadian study, it was shown that 16% of laboratory tests were requested more than necessary.[14] Similarly, in another study conducted in Turkey, the frequency of unnecessary laboratory test repetitions was found to be 16.2%.[15] In a 15-year meta-analysis study, which is the most comprehensive study on this subject, unnecessary test repetitions of laboratory tests were found to be 7.4%.[16] In our study, unnecessary laboratory test repetitions were found to be 6.2%. Although the result of our study is close to the result of the meta-analysis study, it was found to be lower than the literature data. This may be due to different conditions. While in many of the existing studies inpatients and outpatients were evaluated together or only inpatients were evaluated, the evaluation of only outpatients in our study may have contributed to the lower rate of unnecessary test repetitions. Two studies in the literature have shown that unnecessary test repetition is lower in outpatients.[15,17]

Studies investigating unnecessary test orders have used restrictive and tolerant criteria.[16] The tolerant criteria used in our study are more flexible in terms of unnecessary test requests. For example, the test is considered appropriate unless it is repeated unnecessarily. In studies where tolerant criteria are used, the rate of unnecessary test orders is expected to be lower.[16] Therefore, the use of tolerant criteria in our study may have resulted in a lower rate of unnecessary test repetitions. Studies using subjective criteria have shown that the rate of unnecessary testing is approximately 2 times higher than those using objective criteria.[16] It is estimated that the inability to disable the researcher's bias, especially in subjective criteria, increases this rate.[16] The fact that the rate of unnecessary test repetitions in our study was lower than in other studies in the literature may also be due to our use of objective criteria.

In our study, unnecessary retest orders were significantly higher in females than in males. Studies investigating the relationship between unnecessary test repetition and gender were limited in the literature. In another study conducted in Turkey, the risk of unnecessary test repetition was found to be higher in men than in women.[15] The fact that 74.82% of the tests were performed on women in our study may also have caused unnecessary test repetition to be high in women. In addition, since women's labor force participation rate in our country is lower than that of men, women’s spending more time at home may also enable women to benefit more from primary healthcare services by providing more access to primary healthcare institutions that are close to households.[18] In a study investigating gender differences in health, it was found that although women had a longer life expectancy, they had more negative experiences in terms of health than men.[19] A Canadian study showed that women consult physicians more often than men.[20] The fact that women apply to physicians more frequently and feel unhealthy may have affected the higher frequency of unnecessary test repetitions in

women. However, this information alone is not sufficient to explain the higher frequency of laboratory test repetitions in women. More comprehensive studies are needed to explain this situation.

In our study, unnecessary retest orders were significantly higher in patients over 65 years of age than in patients younger than 65 years old. In a study conducted in Australia, a relationship was found between patients over 65 years of age and unnecessary test repetitions, and the result is in line with our study.[21] In another study conducted in Turkey, it was found that unnecessary test repetitions were more common over the age of 65.[15] Although these data in the literature were consistent with the results of our study, more studies investigating the relationship between age and unnecessary test repetition could not be found. In a study conducted in Canada, it was shown that laboratory tests and health expenditures increased in correlation with patient age.[22] The increase in comorbid diseases associated with aging may also cause the elderly population to benefit more from health services, and indirectly, to repeat laboratory tests more frequently.[23] In addition, due to the high risk of additional disease in the elderly, physicians may have shown a more defensive approach to older patients and repeated the tests more frequently.

In our study, the test with the highest rate of unnecessary repetition was vitamin B12 (32.5%). While the rate of unnecessary use of the vitamin B12 test was found to be 8.22% in a study conducted in Canada[24], the unnecessary use rate of the vitamin B12 test was found to be 28.4% in another study conducted in the same country.[14] While this rate was 14.6% in a study conducted in our country[15], it was found to be 18.2% in another study conducted in Italy.[25] The rates reached in the literature were relatively low compared to our result. The minimum repetition time intervals referenced in the studies in the literature varied. In some studies, the minimum repetition time intervals were determined to be lower than in our study, which may have resulted in lower unnecessary testing rates. However, this situation will not explain the lower rate of unnecessary requests for vitamin B12 in the study in which the same minimum repetition time interval was used as in our study. In addition, the follow-up and treatment of vitamin deficiencies by primary care physicians may have caused the unnecessary test repetition of vitamin values in primary care. The fact that vitamins (vitamin B12, folate, and vitamin D) formed the three tests with the highest rate of unnecessary repetition in our study strengthens this possibility. In addition, patients stated that they obtained information about vitamins from social media, other media outlets, other patients, and health professionals, and explained their symptoms with the information they obtained about the symptoms caused by vitamin deficiencies.[26] In the same study, physicians stated that if patients insist on their vitamin test requests despite adequate explanation, they accept vitamin test requests to maintain a good relationship with the patient and avoid conflicts. [26] All these situations may have increased the frequency of unnecessary vitamin test repetitions.

In our study, the 4-year total cost of unnecessary test repetitions was found to be ₺5,479,093.37. The total cost calculated was only obtained from the unit costs of the unnecessarily repeated tests, and the costs that the tests

lead to (other laboratory expenses, treatments, referral to hospital, hospitalization, etc.) were not taken into account. This may have caused the total cost to be lower than the actual total cost.

There was a significant increase of 123.6% in the use of 25 laboratory tests evaluated between 2016 and 2019. It was found that laboratory tests used in primary healthcare facilities in the United Kingdom increased by 24.2% between 2005 and 2009.[27] In a study conducted in a tertiary university hospital in Sweden, it was determined that the number of laboratory tests increased by 70% in 7 years.[1] In our study, the rate of increase in laboratory tests was higher than other studies in the literature. The reason for this may be that while all tests performed in the laboratory were included in other studies, a relatively limited number of tests were included in our study.

Various interventions have been developed for the appropriate use of laboratory tests. Considering the widespread use of laboratory tests by primary care physicians, these interventions will not provide a wide-ranging benefit without being implemented in primary care.[8] Studies have shown that education leads to a significant decrease in the number of laboratory test requests by physicians.[28] Publishing guidelines for family physicians on the use of laboratory tests and providing training to family physicians may also improve the use of laboratory tests in primary care. Hoffman and Kanzaria argued that to solve the problem of extremism in medicine, it is necessary to define and accept that there is an inevitable margin of miss in medicine, to break the demigod perception of society about physicians with education, and to reform the malpractice law for this purpose.[29] Aiming only at reducing costs while improving the use of laboratory tests may not provide long-term benefits. Aiming at both the cost and effectiveness of healthcare will ensure that the programs to be implemented will be more efficient.

As a result, in this study, it was found that unnecessary test repetitions were quite high among the laboratory tests requested by family physicians working in primary care. This situation brings a very high amount of unnecessary financial burden to the Social Security Institution of our country. Training family physicians on this issue and making adequate legal arrangements to protect physicians from malpractice can prevent unnecessary test repetitions.

The study had some limitations. No criteria other than the test request time interval were used to determine the tests as unnecessary. In the study, it was assumed that laboratory tests that fit the test request time interval were requested appropriately. In addition, tests considered unnecessary repetitions may have included tests requested to confirm the previous abnormal result. Another limitation is that we do not have information about the clinical status of the patients. Acute changes in the patient's clinical condition may have caused physicians to make frequent test requests. However, patients with sudden clinical changes are less likely to be followed up in primary care. Evaluation of a wide range of physicians and patients constitutes the strength of the study.

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Ethical Considerations: This study was approved by the Necmettin Erbakan University, Faculty of Medicine Non-Pharmaceutical and Medical Device Ethics Committee (04.09.2020/115).

Conflict of Interest: The authors declare no conflict of interest.

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