

# Effect of the characteristics of family physicians on their utilisation of laboratory tests

Shlomo Vinker, Ifat Kvint, Rina Erez, Asher Elhayany and Ernesto Kahan

## ABSTRACT

### Background

The use of laboratory tests by family physicians has increased in recent years.

### Aims

To evaluate the relationship between family physicians' characteristics and the number and type of laboratory tests requested, taking into account chronic diseases.

### Design of study

Retrospective, cross-sectional study.

### Setting

One hundred and sixty-two physicians treating 230 123 patients in one district of a health management organisation in Israel.

### Method

Physicians' use of 16 common types of laboratory tests was assessed in relation to physicians' demographic, professional, and clinic characteristics. The utilisation rate over 1 year was divided into quintiles for each laboratory test, and each physician was given a global laboratory score (for each test the physician got a score from 1 (utilisation in the lower quintile) to 5 (higher quintile). The global score was the sum of scores of the individual tests.

### Results

On logistic regression analysis, four background characteristics were associated with the global score for the utilisation of laboratory tests. The highest hazard ratios were for being a female doctor (3.2, 95% confidence interval [CI] = 1.5 to 6.5), working in an urban clinic (3.2, 95% CI = 1.1 to 9.8), and having a greater workload than doctors in rural clinics (1.4, 95% CI = 1.1 to 1.8). Being a graduate of a Western country or Israel had a negative association with the global score (0.4, 95% CI = 0.1 to 0.99).

### Conclusion

Female sex and working in a urban clinic were major factors in the use of laboratory tests in clinical practice. As more women enter the medical profession, an improved understanding of the sex differences in ordering medical tests is important.

### Keywords

family physician; laboratory test; utilisation.

## INTRODUCTION

The use of laboratory tests by family physicians has increased in recent years. Some physicians assume that routine laboratory tests are safe to perform, save time and money, and instill a sense of security and satisfaction in patients.<sup>1</sup> Others send patients for testing because of work pressure, lack of confidence in the diagnosis, or by force of habit.<sup>2</sup> Some studies have been performed to improve understanding of these different working habits.<sup>3-11</sup>

Groups of physicians were asked by researchers to write up requests for laboratory tests in simulated situations.<sup>3-5,10</sup> Results suggest that test-ordering behaviour is determined more by personal habits and characteristics than by objective evidence and clinical need.<sup>3</sup> This is supported by the high correlation of physician responses between one vignette and the next.<sup>5</sup> Differences in the number and, to some extent, the nature of the tests ordered were detected by area of expertise and within specialty subgroups.<sup>4,5</sup>

Using a cross-sectional questionnaire design, Franks *et al*<sup>6</sup> found that higher rates of laboratory referrals by community physicians were associated with female sex of the physician and professional seniority.<sup>6</sup> Hartley *et al* reported a similar finding.<sup>9</sup> However, Salloom and Franssen<sup>10</sup> found that doctors who had been practising for less than 10 years tended to order more tests and more expensive ones. De Gracia Gomis *et al* observed that, although

*S Vinker, MD, senior lecturer; I Kvint, MD, trainee; R Erez, MD, instructor; E Kahan, MD, senior lecturer, Department of Family Medicine, Tel Aviv University, Israel. A Elhayany, MD, lecturer, general manager, Central District, Clalit Health Services, Rishon Lezion, Israel.*

### Address for correspondence

Dr Shlomo Vinker, Department of Family Medicine, Tel Aviv University, PO Box 14238, Ashdod 77041, Israel. E-mail: vinker01@zahav.net.il

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## How this fits in

Previous research has shown considerable variation in the utilisation of laboratory tests by family physicians. Test-ordering behaviour has been associated with objective evidence and clinical need, as well as personal habits and characteristics. Previous study findings show that female doctors ordered more tests, while other characteristics like workload and professional characteristics, had inconsistent effects. This study reveals that, after controlling for the prevalence of relevant chronic diseases, the two major contributors to higher utilisation are physicians' sex (female) and working in an urban clinic (higher workload). Further study is required to evaluate whether the differences are the result of one group of physicians ordering too many tests or another group not ordering enough tests.

female doctors ordered more tests than male doctors, more of the tests were ordered for male than for female patients.<sup>11</sup>

The aim of this large-scale study was to evaluate the possible relationship between family-physician characteristics and the number and type of laboratory tests requested, while taking into account the chronic-disease burden in the relevant laboratory tests.

### METHOD

The study was conducted in the Central District primary care clinics of Clalit Health Services. This is the largest health-management organisation (HMO) in Israel. It covers more than 50% of the country's population and cares for more than 70% of older patients (aged 65 years and above) in Israel.<sup>12</sup>

The mean income of persons insured by this HMO is lower than those insured by the other large health funds. This HMO has a nationwide framework of eight districts; the Central District population is representative of the HMO population in its sociodemographic characteristics.<sup>13</sup> Every person insured by Clalit Health Services is allocated to a primary care physician who could be a family physician or a pediatrician. Patients only see the doctor to whom they are allocated, except when their physician is on holiday, when patients are away from their local area, or when there is an emergency and their physician is not working. For each visit that is not with their primary care physician, a special administrative certificate of approval is needed and the peer physician is instructed to give only first aid.

The present study covered laboratory testing by all family physicians employed in the Central District in or before June 2002 and throughout 2003. Physicians not working exclusively with Clalit Health Services and those treating fewer than 250 patients were not included.

Physicians' background data were derived from the employment and administrative database of the district. These included:

- age,
- sex,
- country of medical school graduation (Israel/Western country or other),
- board certification in family medicine,
- position in clinic (medical manager or not), and
- clinic location (urban or rural).

The number of patients allocated to each physician had been derived from the HMO registry.

### Laboratory tests included in the analysis

Laboratory data were retrieved from the computerised records of the central laboratory of the Clalit Health Services, which performs all tests in the Central District. All laboratory tests performed in 2003 were retrieved and divided according to laboratory test type (biochemistry, hormones, and cancer markers). Tests were subgrouped into types that are usually taken together (lipids profile, liver function tests, and kidney function tests). From each of the most commonly used test subgroups, one representative laboratory test was selected. A total of 16 types of tests were included in the study:

- complete blood count,
- glutamate oxaloacetate transaminase,
- total cholesterol,
- urea,
- glycosylated haemoglobin (HbA1c),
- thyroid-stimulating hormone,
- C-reactive protein,
- vitamin B12,
- prostate specific antigen,
- *Helicobacter pylori* antibodies,
- rheumatoid factor,
- Epstein-Barr virus antibodies,
- international normalised ratio,
- antinuclear factor,
- cancer antigen CA15-3, and
- carcinoembryonic antigen.

Age-adjusted number of patients allocated to each physician served as the denominator in the calculation of the rate of laboratory test utilisation for each physician.

### Age-adjusted number of patients

The age-adjusted number of patients allocated to each physician was calculated according to the number of allocated patients, age distribution, and the capitation formula of the National Insurance Institute of Israel, which gives a different weight for each age group according to its health-services utilisation.<sup>14</sup>

### Workload

Visiting a primary care physician in Clalit Health

Services HMO is free of charge. As the number of encounters of each physician were not known, age-adjusted number of patients was used as a marker of each physician's workload.

Working in an urban clinic in the HMO investigated represents a higher workload. In rural clinics there are fewer patients allocated to each physician and the ratio of nurses to physicians is greater in rural than in urban clinics.

### Relevant chronic diseases

The number of patients with diabetes mellitus, hyperlipidemia, thyroid diseases, and chronic renal failure were derived from the HMO registry. It was assumed that the following laboratory tests may be strongly related to the prevalence of common chronic diseases: glycosylated haemoglobin (HbA1C); diabetes mellitus; total cholesterol; hyperlipidemia; thyroid stimulating hormone; thyroid diseases; urea; and chronic renal failure. The age-adjusted number of patients allocated to each physician was used as the denominator in calculating the prevalence of chronic diseases for each physician's clinic.

### Global laboratory score calculation

The utilisation rate of each laboratory test per physician was divided into quintiles. For each of the 16 laboratory tests, the physician was scored from 1 (utilisation in the lower quintile) to 5 (utilisation in the higher quintile). The global laboratory score of each physician was calculated as the sum of scores of the individual tests.

### Statistical analysis

Data were analysed using SPSS (version 13.0). The association between physicians' background data and their laboratory test utilisation was examined using a multivariate logistic regression model. The model was devised to examine the effect of background, clinic variables, and relevant chronic diseases on laboratory test utilisation. In this model, each physician's utilisation of each individual laboratory test and the global laboratory score were divided at the median-to-high utilisation and low utilisation levels. Statistical significance was set at  $P = 0.05$ .

## RESULTS

A total of 162/217 (74.7%) of the family physicians employed in the Central District clinics of the Clalit Health Services met the study's inclusion criteria. These physicians treated 230 123 patients. The mean number of patients allocated to each physician was 1420 (1922 age-adjusted patients).

Table 1 presents the demographic, professional, and clinical characteristics of the family physicians. The total and mean age-adjusted numbers of

**Table 1. Demographic, professional, and clinic characteristics of participant physicians (n = 162).**

Variable	
Age	48.4 (SD = 7.9)
Sex	
Males	n = 70
Females	n = 92
Years since graduation	8.1 (SD = 20.7)
Location of medical school graduation	
Israel	31 (19.1%)
Western country	3 (1.9%)
Former Soviet Union	100 (61.7%)
Others	28 (17.3%)
Board certification	
Yes	60 (37.0%)
No	102 (63.0%)
Clinic medical manager	
Yes	29 (17.9%)
No	133 (82.1%)
Clinic location	
Urban	141 (87.0%)
Rural	21 (13.0%)
Patients allocated to each physician	
Nominal	1420.5 (SD = 397.6)
Age adjusted <sup>a</sup>	1922.6 (SD = 619.3)
Patients with chronic diseases <sup>b</sup>	
Hyperlipidemia	30.5 (SD = 114.02)
Diabetes	15.7 (SD = 54.41)
Thyroid disease	7.1 (SD = 17.97)
Chronic renal insufficiency	3.9 (SD = 5.4)

<sup>a</sup>Age-adjusted number of patients allocated to each physician was calculated according to the number of allocated patients, age distribution, and the capitation formula of the National Insurance Institute of Israel, which gives a different weight for each age group according to its health-services utilisation. <sup>b</sup>Prevalence per 1000 age-adjusted patients.

laboratory tests ordered by the physicians in 2003 are summarised in Table 2.

### Association between background characteristics and the global score for laboratory test utilisation

The association between family physicians' backgrounds and the global score for laboratory test utilisation is detailed in Table 3. Results showed that four background characteristics were associated with the global score for laboratory test utilisation.

The highest hazard ratios (HRs) were for being a female doctor (3.2, 95% confidence interval [CI] = 1.5 to 6.5) and working in an urban clinic (3.2, 95% CI = 1.1 to 9.8). Being a graduate of a Western country or Israel had a negative association with the global score (0.4, 95% CI = 0.1 to 0.99).

### Association between background characteristics and specific laboratory-test utilisation

HRs (95% CI) from multivariate logistic regression

**Table 2. Number of laboratory tests ordered per 1000 age-adjusted patients.<sup>a</sup>**

Type of laboratory test	Total annual number	Mean number per physician Mean (SD)
Complete blood count	262 918	851.5 (257.1)
Urea	215 327	673.9 (195.7)
Glutamine oxaloacetate transaminase	171 747	542.9 (137.8)
Total cholesterol	149 205	470.6 (99.2)
International normalised ratio	95 216	292.8 (133.6)
Thyroid-stimulating hormone	76 772	251.9 (96.1)
Vitamin B12	41 789	134.0 (83.3)
Haemoglobin A1c	33 087	103.8 (28.0)
C-reactive protein	12 562	40.0 (17.4)
Prostate-specific antigen	12 132	37.7 (20.9)
Antinuclear factor	6154	19.8 (11.8)
Rheumatoid factor	6040	19.6 (10.5)
Carcinoembryonic antigen	5937	18.4 (10.0)
Helicobacter pylori antibodies	5075	16.7 (13.9)
CA 15-3	3740	11.8 (7.3)
Epstein-Barr virus antibodies	2717	10.1 (10.8)

<sup>a</sup>Age-adjusted number of patients allocated to each physician was calculated according to the number of allocated patients, age distribution, and the capitation formula of the National Insurance Institute of Israel, which gives a different weight for each age group according to its health services utilisation.

analysis were calculated for the relative contribution of each of the background characteristics to the utilisation of laboratory tests (Supplementary Table 1).

Results showed that sex was the strongest characteristic associated with laboratory requests. This was demonstrated in five specific tests, with female physicians ordering more tests than male physicians. The highest HRs were for CA 15-3 (4.7, 95% CI = 2.2 to 9.7), HbA1c (3.8, 95% CI = 1.8 to 8.3),

**Table 3. Logistic regression model for the association between physicians' background characteristics and laboratory test request rates per 1000 age-adjusted patients.<sup>a</sup>**

	Global laboratory score	
	Hazard ratio	95% CI
Sex (female)	3.2	(1.5 to 6.5) <sup>b</sup>
Workload (high)	1.4	(1.1 to 1.8) <sup>b</sup>
Location (urban)	3.2	(1.1 to 9.8) <sup>b</sup>
Graduate (Western country/Israel)	0.4	(0.1 to 0.99) <sup>b</sup>
Board certification	0.9	(0.4 to 2.2)
Seniority	1.1	(0.8 to 1.5)

<sup>a</sup>Age-adjusted number of patients allocated to each physician was calculated according to the number of allocated patients, age distribution, and the capitation formula of the National Insurance Institute of Israel, which gives a different weight for each age group according to its health services utilisation. <sup>b</sup>P<0.05 sex: female doctors>male doctors; workload: age-adjusted patients allocated to physician divided into quintiles; location: urban clinics>rural clinics; medical school: Israel and Western countries>others; Board certification: yes>no; seniority: years since graduation divided into quintiles.

vitamin B12 (3.2, 95% CI = 1.6 to 6.5), and total cholesterol (2.5, 95% CI = 1.2 to 5.2).

Workload and clinic location were the next characteristics most strongly associated with laboratory requests. Physicians in larger practices (higher age-adjusted mean number of patients per physician) ordered more tests per patient than physicians in smaller practices. The highest HRs were for carcinoembryonic antigen (1.7, 95% CI = 1.3 to 2.2) and glutamate oxaloacetate transaminase (1.5, 95% CI = 1.2 to 1.9). Physicians working in urban clinic ordered more tests per patient than physicians in rural clinics. The highest HR was for international normalised ratio (3.7, 95% CI = 1.2 to 10.7).

Weaker predictors were seniority (one test) and being a graduate of a medical school in Israel or a Western country (two tests). Board certification in family medicine had no effect on individual laboratory tests utilisation.

There was no association between any of the background variables and the ordering of antinuclear-factor and rheumatoid-factor tests, or between position at clinic (medical manager or not) and the ordering of any of the laboratory tests.

## DISCUSSION

### Summary of main findings

The present study evaluated the association between background demographic and professional characteristics of 162 family physicians and their use of a representative range of laboratory tests over 1 year. On multivariate analysis, the strongest predictors of laboratory-test utilisation were physicians' sex, clinic location, and workload. Other significant factors included the country where the physician studied medicine but not the professional status, seniority, or position in the clinic (medical manager or not).

In this study, the prevalence of relevant chronic diseases was included in the model of laboratory-test utilisation; this was done to control for the prevalence of some chronic diseases that are strongly associated with a specific laboratory test. For example the test for HbA1c is recommended only in the case of diabetes mellitus follow-up. If, after controlling for the prevalence of diabetes in the regression model, there are still effects of the physician's sex and clinic location, it can be assumed that physician and clinic characteristics have an effect on the number of tests carried out.

Physicians' countries of study had a non-significant effect on most individual laboratory tests, but a significant effect on the global laboratory score. Graduates of Western medical schools ordered substantially fewer laboratory tests than graduates of the former Soviet Union and others.

The professional status, seniority, and position in the clinic (not included in the final regression model) did not contribute to the variation in laboratory-test utilisation. Further studies are needed to resolve this issue.

Medical managers are more aware of the economic aspects of their work, but doctors' positions in clinics had no effect on laboratory-test utilisation in the present study. This finding may indicate that future attempts to reduce the number of tests because of economic arguments are likely to fail. This is because medical managers of primary care clinics are often responsible for the clinic's budget and are expected to emphasise economics in their clinical decision making.

### **Strengths and limitations of the study**

A limitation of this study is that it is not known whether the doctors studied are, in general, ordering the necessary and adequate type and number of tests. Although fewer tests are cheaper in the short term, there are situations where more testing leads to better patient outcomes. The number of diagnostic tests ordered by primary care physicians is growing; many of these tests seem to be unnecessary according to established, evidence-based guidelines.<sup>16</sup>

The strengths of the study are that it evaluated a large number of physicians and a broad spectrum of laboratory tests. This study also benefited from the addition of relevant chronic disease prevalence to the explanatory statistical model.

### **Comparison with existing literature**

**Physicians' sex.** This study showed that female doctors used more laboratory tests in the course of their work than male doctors. This finding is in concordance with previous studies.<sup>6,10,15</sup> As more women are entering the medical profession, it is important to understand the origins of this tendency and to evaluate whether they are ordering too many tests or whether male physicians are not ordering enough.

**Workload.** Physician workload can be defined in various ways. In the present study, higher workload, as measured by the age-adjusted patient allocation per physician, was a significant factor that influenced the requests for laboratory tests.

Likewise, a recent study reported a positive association of the number of physician workdays with utilisation of laboratory tests.<sup>17</sup> Leurquin *et al*<sup>18</sup> compared differences in the use of blood tests in eight European countries. The factor that most significantly contributed to the large variation among countries was the number of physicians per 1000 inhabitants. A physician's personality had no effect. A

high workload may leave physicians less time to talk to each patient and to achieve a diagnosis by anamnesis and physical examination alone, thereby encouraging them to order more laboratory tests to avoid errors and save time.

Bugter-Maessen *et al*<sup>19</sup> evaluated which family doctors would benefit most from an intervention programme to reduce the use of laboratory tests. They found that physicians with more years of experience who worked less hours per week responded best. Those who were less experienced and who worked more hours asked for more tests (that is, those who needed the intervention programme more) found it difficult to change their behavioural patterns.

Vardy *et al*<sup>20</sup> found that replacing personal laboratory routines with uniform consensus routines proved to be successful in reducing the quantity of laboratory tests ordered. They assumed that this process reduced unnecessary tests and improved the quality of practice.

**Clinic location.** Israel is a small country, and there is almost no difference between rural and urban areas in terms of proximity and accessibility to primary care and other medical facilities. Most doctors who work in rural areas also practice at a second clinic in town. The ratio of doctors to nurses in rural clinics is more favourable than that of urban clinics, as: for a given population with the same number of physicians, there are relatively more nurses working in rural clinics. Therefore, reduced workload is not completely represented by the age-adjusted number of allocated patients.<sup>19</sup> Lower laboratory utilisation rates in rural clinics may be partially explained by their lower workload.

### **Implications for future research and clinical practice**

This study of a single large health-maintenance organisation revealed differences among physicians in their use of laboratory tests. The two major contributors to higher utilisation were physician sex (female) and workload (high). There is a need for further study to evaluate whether the differences are the result of ordering too many tests by one group or not enough tests by the other group. Once these differences are determined, strategies can be developed to optimise the utilisation of laboratory tests in general practice.

### **Supplementary information**

Additional information accompanies this article at <http://www.rcgp.org.uk/bjgp-supinfo>

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The authors have stated that there are none.

**REFERENCES**

- Higgins JC. The status of physician office labs since CLIA '88. *J Med Pract Manage* 2000; **16**(2): 99–102.
- Van der Weijden T, van Bokhoven MA, Dinant GJ, et al. Understanding laboratory testing in diagnostic uncertainty: a qualitative study in general practice. *Br J Gen Pract* 2002; **52**(485): 974–980.
- Malcolm L, Wright L, Seers M, et al. Laboratory expenditure in Pegasus Medical Group: a comparison high and low users of laboratory tests with academics. *N Z Med J* 2000; **113**(1105): 79–81.
- Linn LS, Yager J, Leake BD, et al. Differences in the numbers and costs of tests ordered by internists, family physicians, and psychiatrists. *Inquiry* 1984; **21**(3): 266–275.
- Yager J, Linn LS, Leake B, et al. Initial clinical judgments by internists, family physicians, and psychiatrists in response to patient vignettes: II. Ordering of laboratory tests, consultations, and treatments. *Gen Hosp Psychiatry* 1986; **8**(3): 152–158.
- Franks P, Williams GC, Zwanziger J, et al. Why do physicians vary so widely in their referral rates? *J Gen Intern Med* 2000; **15**(3): 163–168.
- Goold SD, Hofer T, Zimmerman M, Hayward RA. Measuring physician attitudes toward cost, uncertainty, malpractice and utilization review. *J Gen Intern Med* 1994; **9**(10): 544–549.
- Zaat JO, van Eijk JT. General practitioners' uncertainty, risk preference, and use of laboratory tests. *Med Care* 1992; **30**(9): 846–854.
- Hartley RM, Charlton JR, Harris CM, Jarman B. Pattern of physicians' use of medical resources in ambulatory settings. *Am J Public Health* 1987; **77**(5): 565–567.
- Salloum S, Franssen E. Laboratory investigations in general practice. *Can Fam Physician* 1993; **39**: 1055–1061.
- De Gracia Gomis MC, Perez Royo A, Hernandez Aguado I, Berbegal R. An analysis of the demand for laboratory tests from primary a health care. *Aten Primaria* 1999; **23**(1): 26–31.
- Chaklai Z. Health in Israel, 2005. [http://www.health.gov.il/Download/pages/Health\\_insurance.pdf](http://www.health.gov.il/Download/pages/Health_insurance.pdf) (accessed 16 Apr 2007).
- Sherf M. *Clalit Health Services districts soci-demographic characteristics in 2006*. (internal report). [In Hebrew.]
- Chernichovski, D. The capitation formula and needed changes. <http://www.knesset.gov.il/mmm/data/docs/m01458.doc> (accessed 16 Apr 2007). [In Hebrew.]
- Kristiansen IS, Hjortdahl P. The general practitioner and laboratory utilization: why does it vary? *Fam Pract* 1992; **9**(1): 22–27.
- Verstappen WH, van der Weijden T, Sijbrandij J, et al. Effect of a practice-based strategy on test ordering performance of primary care physicians: a randomized trial. *JAMA* 2003; **289**(18): 2407–2412.
- Verstappen WHJM, ter Riet G, Dubois WI, et al. Variation in test ordering behaviour of GPs: professional or context-related factors? *Fam Pract* 2004; **21**(4): 387–395.
- Leurquin P, Van Casteren V, De Maeseneer J. Use of blood tests in general practice: a collaborative study in eight European countries. Eurosentinel Study Group. *Br J Gen Pract* 1995; **45**(390): 21–25.
- Bugter-Maessen AM, Winkens RA, Grol RP, et al. Factors predicting differences among general practitioners in test ordering behaviour and in the response to feedback on test requests. *Fam Pract* 1996; **13**(3): 254–258.
- Vardy DA, Simon T, Limoni Y, et al. The impact of structured laboratory routines in computerized medical records in a primary care service setting. *J Med Syst* 2005 Dec; **29**(6): 619–626.
- Mordechai Shani, MD. Primary care in Israel: recommendations of the National Council for Health in the Community. *IMAJ* 2001; **3**: December: 881–882.