

Fasting Duration and Differences Across Routine Laboratory Tests

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IMPORTANCE Fasting before blood collection is widely practiced to reduce preanalytical variability, yet whether fasting-related differences are clinically meaningful across a broad panel of routine analytes has not been systematically evaluated using clinical data.

OBJECTIVE To evaluate whether fasting duration is associated with routine laboratory test results and whether observed differences exceed established analytical performance specifications (APS).

DESIGN, SETTING, AND PARTICIPANTS Retrospective single-center cross-sectional study using laboratory information system data collected between February 2021 and December 2023 from a single 670-bed secondary-care university hospital in the Seoul metropolitan area, Republic of Korea. All samples were drawn from outpatients at the institution's central phlebotomy unit. Participants were adult outpatients (≥ 18 years) with documented fasting duration. Data were analyzed from January 1, 2024, to July 24, 2026.

EXPOSURE Fasting duration derived from the time elapsed between the patient's last meal and blood collection, categorized as less than 8 hours, 8 to 12 hours, and more than 12 hours.

MAIN OUTCOMES AND MEASURES Adjusted means across fasting groups were estimated using linear mixed-effects models with patient-level random intercepts, adjusting for age, sex, and department. Paired within-person analyses among repeatedly tested patients were performed to minimize between-patient confounding. Differences were compared with the European Federation of Clinical Chemistry and Laboratory Medicine biological variation-based total allowable error. Postprandial trends within the subgroup fasting less than 8 hours were assessed at 30-minute intervals.

RESULTS The final dataset comprised 9 755 547 test results from 101 148 patients across 372 test items. Between-group comparisons identified APS-exceeding differences for 27 analytes. However, only 10 were confirmed in paired within-person analyses, suggesting confounding. Glucose (10.8%), triglycerides (20.1%), γ -glutamyl transferase (14.8%), and lipase (36.4%) were higher with less than 8 hours fasting. No analyte exceeded APS between the 8- to 12-hour and more than 12-hour groups. Within the less than 8-hour subgroup, glucose and lactate decreased significantly with increasing fasting duration, whereas lipid concentrations showed no significant linear trend.

CONCLUSIONS AND RELEVANCE This cross-sectional study found that fasting duration was associated with differences exceeding analytical performance specifications for only a few analytes, mainly glucose, triglycerides, γ -glutamyl transferase, and lipase. No estimable within-person difference between the 8- to 12-hour and more than 12-hour groups exceeded an available APS. These findings support analyte-specific rather than uniform fasting requirements.

[+ Invited Commentary](#)

[+ Supplemental content](#)

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Clinical laboratory tests inform a large share of clinical decisions, and many measurements are sensitive to pre-analytical conditions, including recent food intake.¹⁻³ To reduce this variability, patients are routinely instructed to fast for 8 to 12 hours before blood sampling, a practice that originated with lipid and glucose testing but is now applied by default to much broader test panels.^{4,5} Recommendations on the optimal fasting duration remain inconsistent.⁶⁻¹¹

The evidence needed to resolve this practice gap is limited in 3 respects. First, it is dominated by lipids.¹²⁻¹⁴ Comparable data are sparse for liver enzymes, pancreatic enzymes, hematologic indices, hormones, and vitamins, even though feeding influences measured parameters.¹⁵⁻²⁴ This uncertainty is reflected in practice: preanalytical requirements have varied across laboratories,²⁵ standardized fasting collection has been recommended to reduce variability,²⁶ and routine fasting for lipid testing has also been questioned.²⁷ Second, the largest studies have compared results from different patients fasting for different durations,^{10,28} so an apparent fasting effect may instead reflect who is tested at which time of day and for what clinical reason; within-person comparisons across fasting conditions have rarely been available. Third, fasting duration has usually been treated as a coarse category, leaving the postprandial time course in the first hours after a meal unresolved, and differences have been reported as statistically significant without reference to any benchmark for clinical relevance, although a discrepancy between requested and actual fasting status can alter diagnostic classifications.²⁹

We addressed these gaps using routinely collected outpatient laboratory data in which fasting duration was prospectively recorded at the phlebotomy unit at the time of venipuncture, in 30-minute increments. This design allowed us to examine 121 routine analytes rather than lipids alone, to compare measurements within the same patients tested under different fasting conditions, and to resolve short-term postprandial trends. Differences were interpreted against analytical performance specifications (APS) derived from biological variation, so that clinically meaningful differences could be distinguished from statistically significant but trivial variation.

Methods

This was a retrospective single-center cross-sectional study. This study was approved by the Institutional Review Board of Inje University Ilsan Paik Hospital with a waiver of informed consent owing to the retrospective nature of the study and the use of deidentified data. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Study Population

All study data were extracted from the hospital laboratory information system, including laboratory results and related metadata (eg, patient demographics and ordering department) during February 2021 to December 2023. Data were analyzed from January 1, 2024, to July 24, 2026. Data for this study were obtained from outpatient blood samples collected at a

Key Points

Question Is fasting duration associated with clinically relevant differences across a broad panel of routine analytes?

Findings In this single-center cross-sectional study of 101 148 adult outpatients with 9 755 547 test results, between-group differences across fasting durations exceeded analytical performance specifications for 27 of the 121 analytes. In paired within-person comparisons, difference persisted for 10 (including glucose, triglycerides, γ -glutamyl transferase, and lipase); the rest were not confirmed within individuals.

Meaning Most routine laboratory tests were minimally affected by fasting duration; analyte-specific rather than uniform fasting requirements may suffice, with adequate fasting reserved for the few analytes whose differences were confirmed within individuals.

single institution, a 670-bed secondary-care university hospital located in the Seoul metropolitan area of Korea. Fasting duration was documented at the outpatient phlebotomy unit (outpatient blood collection room) at the time of venipuncture and was routinely recorded only when at least one test explicitly requiring fasting was ordered concurrently.

Patients were categorized according to fasting status into 3 groups: less than 8 hours fasting, 8 to 12 hours fasting, and more than 12 hours fasting. In the less than 8 hours fasting subgroup, the approximate time since the last meal was recorded in 30-minute intervals, ranging from 30 minutes up to 7 hours 30 minutes, enabling detailed examination of short-term postprandial effects.

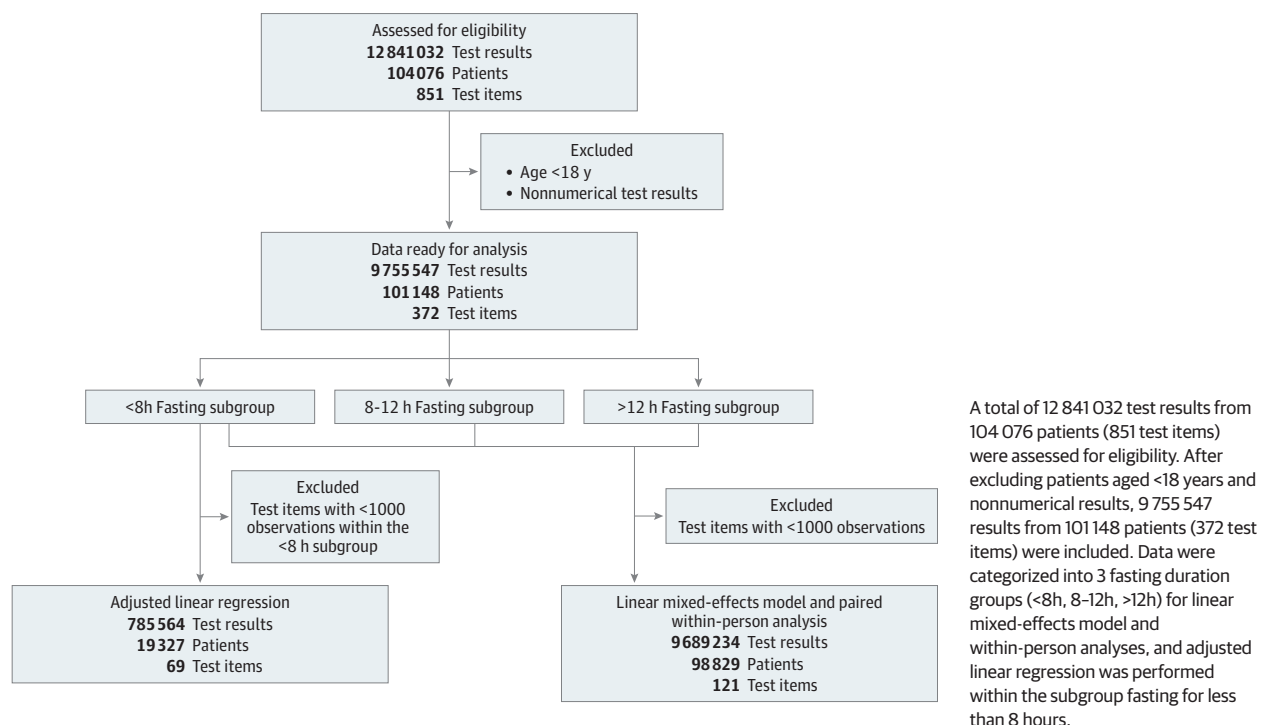
Statistical Analysis

Three complementary analytical approaches were used: a between-group comparison using linear mixed-effects models, a within-person comparison using paired analysis, and a time-trend analysis within the subgroup fasting less than 8 hours.

For the between-group comparison across the 3 fasting duration groups (<8 hours, 8-12 hours, and >12 hours), we fitted linear mixed-effects models with a random intercept for each patient, adjusted for age, sex, and ordering department. The random intercept accounts for the nonindependence of the repeated measurements from the same patient. The mixed-effects models included 38 parameters (an intercept, 2 indicator terms for fasting duration group, age, sex, and 33 indicator terms for ordering department), which, based on the general guideline of at least 10 observations per parameter, required a minimum of 380 data points.³⁰ To ensure robust parameter estimation, we applied a more conservative inclusion threshold and retained only test items with at least 1000 observations, and test items not meeting this threshold were excluded from both the between-group and the within-person analyses, leaving 121 test items. Adjusted means with 95% CIs were estimated for each group, and between-group differences were obtained as pairwise contrasts.

For the paired within-person comparison, analyses were restricted to patients who underwent the same test under 2 different fasting durations across separate visits. For each such patient, the difference between the 2 measurements was calculated. The mean within-person difference was expressed as

Figure. Flowchart of Data Selection and Analysis



a percentage of the mean value of the reference group among the paired patients, with 95% CIs; the reference group was the longer-fasting group of each pairwise comparison (for example, the >12-hour group in the <8-hour vs >12-hour comparison). Comparisons in which fewer than 30 patients contributed a pair of measurements were not estimated.

For the subgroup fasting less than 8 hours, an age-, sex-, and department-adjusted linear regression was conducted to examine short-term postprandial trends, excluding test items with fewer than 1000 observations. Fasting time was modeled categorically using 15 half-hour levels to estimate adjusted means at each time point. In a separate model, fasting duration was modeled continuously to estimate the difference per additional hour of fasting. The model included 50 parameters—age (continuous), sex (2 levels), department (34 levels), and an intercept—requiring at least 500 observations for stability.³⁰ Again, a conservative cutoff of 1000 was used to enhance statistical power and model robustness.

Analytical performance specifications (APS) define the largest difference in a laboratory result that is still acceptable without materially affecting clinical interpretation. We used the optimal APS for total allowable error (TEa) derived from within- and between-participant biological variation (European Federation of Clinical Chemistry and Laboratory Medicine [EFLM] Biological Variation Database; accessed July 6, 2026), which reflect the inherent physiological variation of each analyte rather than technical or regulatory feasibility.³¹ A fasting-related difference smaller than the APS is therefore unlikely to be clinically important, whereas a difference exceeding the APS may be large enough to alter clinical interpretation or

decisions. Maximum percentage differences between fasting duration groups were compared against these specifications. The EFLM Biological Variation Database is periodically updated as new studies become available, so these specifications are subject to change.

All analyses were performed using R version 4.3.3 (The R Project for Statistical Computing). Between-group and within-person comparisons are summarized as differences with 95% CIs. For the less than 8-hour subgroup, the adjusted change per additional hour of fasting (regression slope) is reported with its 95% CI, and the percentage difference between 0.5 and 4 hours after the last meal was calculated from the corresponding adjusted means.

Results

The **Figure** presents the flowchart of data selection and analysis. We analyzed 1 278 644 samples comprising 12 841 032 laboratory test results from 104 076 patients, covering 851 different test items. After excluding samples from patients younger than 18 years and tests yielding non-numerical results, the final dataset included 1 092 848 samples with 9 755 547 numerical results from 101 148 adult patients across 372 test items. The median age was 61 years (IQR, 49-73), with 57% of results from male patients (Table 1). Most tests were drawn after prolonged fasting (>12 h group, approximately 90% of results), whereas 8.3% were in the less than 8 hours fasting duration group and only 1.6% in the 8- to 12-hour group (Table 1). After applying the prespecified observation thresholds, 121 test items were analyzed in the between-group and within-person

Table 1. General Characteristics of the Study Population and Laboratory Tests

Characteristic	Value
Patients	
Total, No.	101 148
Age, mean (SD), y	60.0 (16.1)
Age, median (IQR), y	61 (49-73)
Age range, y	18-106
Test results by patient sex, No. (%)	
Male	5 537 897 (57)
Female	4 217 650 (43)
Laboratory tests, No.	
Total test results	9 755 547
Test items	372
Test categories, No. (%)	
Hematology and coagulation	3 605 282 (37.0)
Kidney function and electrolyte tests	2 119 266 (21.7)
Liver function tests	1 205 887 (12.4)
Lipid profile	808 628 (8.3)
Glucose and diabetes-related tests	753 949 (7.7)
Hormones and endocrine function	140 836 (1.4)
Others	1 121 699 (11.5)
Test-ordering department, No. (%)	
Endocrinology	2 076 026 (21.3)
Cardiology	1 338 921 (13.7)
Health care center	938 772 (9.6)
Gastroenterology	885 140 (9.1)
Nephrology	769 993 (7.9)
Others	3 746 695 (38.4)
Fasting duration groups, No. (%)	
<8 h	810 856 (8.3)
0.5-2 h	278 020 (34)
2.5-5 h	463 923 (57)
5.5-7.5 h	68 913 (8.5)
8-12 h	158 724 (1.6)
>12 h	8 785 967 (90)

analyses. Characteristics by fasting duration group are provided in the eTable 1 in [Supplement 1](#).

Between-Group Differences in Adjusted Means

Adjusted means for representative analytes are shown in [Table 2](#). The SI conversion factors for all conventional units are reported in the SI conversion factor footnote to [Table 2](#). All analytes are given in eTable 2 in [Supplement 1](#), and the eFigure in [Supplement 2](#) shows 4 representative patterns. The maximum difference between fasting duration groups exceeded the TEa specification for 27 of the 121 analytes (eTable 5 in [Supplement 1](#)).

Within-Person Differences by Fasting Duration Group

Because the 3 fasting duration groups did not comprise the same patients, each flagged comparison was reexamined within individuals tested under more than one fasting condition (eTable 6 in [Supplement 1](#)). Of the 27 analytes exceeding the specification between groups, 10 were reproduced within

individuals. Glucose (10.8% [95% CI, 10.0% to 11.6%]), triglycerides (20.1% [95% CI, 17.4% to 22.8%]), γ -glutamyl transferase (GGT) (14.8% [95% CI, 3.9 to 25.7%]), and lipase (36.4% [95% CI, 15.7% to 57.1%]) were higher with less than 8 hours fasting, whereas total bilirubin (−17.0% [95% CI, −18.2% to −15.9%]) and 25-hydroxyvitamin D (−9.9% [95% CI, −14.4% to −5.4%]) were higher with fasting more than 12 hours; whole-blood glucose, CA 125, and total carbon dioxide were also reproduced. The remaining 17 analytes either lost statistical significance within individuals or could not be estimated because fewer than 30 patients contributed paired measurements, indicating that these between-group differences largely reflected differences between patients rather than fasting duration (eTable 3 in [Supplement 1](#)).

No analyte exceeded the TEa specification in within-person comparisons between the 8- to 12-hour and more than 12-hour groups (glucose, −0.7% [95% CI, −1.4% to 0.0%]; triglycerides, 2.4% [95% CI, 0.1% to 4.6%]; GGT, 0.9% [95% CI, −5.4% to 7.3%]). The lipid and liver-enzyme elevations with prolonged fasting suggested by between-group comparisons were not reproduced within individuals.

White blood cell subsets showed small within-person differences between the less than 8 hours and more than 12 hours groups. Neutrophil counts were higher with shorter fasting (8.2% [95% CI, 7.1% to 9.3%]), whereas lymphocyte percentage (−7.8% [95% CI, −8.3% to −7.3%]) and eosinophil percentage (−8.7% [95% CI, −10.2% to −7.3%]) were lower. All were close to or within their specifications (8.8%, 7.5%, and 14.9%, respectively) and showed no difference between the 8- to 12-hour and more than 12-hour groups.

Pancreatic enzymes were also higher with shorter fasting in within-person comparisons (<8 vs >12 hours): lipase, 36.4% (95% CI, 15.7% to 57.1%), exceeding its specification (6.3%), and amylase, 4.6% (95% CI, 0.2% to 8.9%), which did not (6.5%). Neither exceeded the specification between the 8- to 12-hour and more than 12-hour groups.

A few analytes showed a within-person difference despite no meaningful between-group difference (eTable 7 in [Supplement 1](#)), most notably the chronic glycemic markers glycated albumin (3.8% [95% CI, 0.3% to 7.4%]) and hemoglobin A_{1c} (2.2% [95% CI, 1.1% to 3.3%]), both higher at less than 8 hours fasting. High-sensitivity C-reactive protein also reached significance, but in only 31 paired patients.

Linear Regression Analysis of Subgroup Fasting Less Than 8 Hours

Adjusted means at each 30-minute interval from 0.5 to 7.5 hours were estimated for the 69 analytes with at least 1000 observations in this subgroup ([Table 3](#); eTable 4 in [Supplement 1](#) for all analytes). Fifteen test items showed a significant linear trend, comprising small upward shifts in hemoglobin, hematocrit, and red blood cell count consistent with mild hemoconcentration, and minor changes in electrolytes, total protein, albumin, and leukocyte subsets. For every analyte except glucose and lactate, the difference between 0.5 and 4 hours after the last meal remained within the EFLM TEa ([Table 3](#)).

Glucose and lactate were the exceptions. Adjusted glucose was lower by 4.3 mg/dL per additional hour of fasting

Table 2. Adjusted Means by Fasting Duration and Within-Person Differences for Representative Routine Analytes by Fasting Duration, Compared With Analytical Performance Specifications

	Adjusted mean (95% CI) ^a			Max diff, % ^b	Within-person difference, % (95% CI) ^c			EFLM, % ^d	Exceeds EFLM ^e
Analyte	<8h	8 to 12 h	>12 h		<8 h vs 8 to 12 h	<8 h vs >12 h	8 to 12 h vs >12 h		
Hematology and coagulation									
HB	13.27 (13.17 to 13.36)	13.25 (13.16 to 13.34)	13.44 (13.35 to 13.53)	1.4	-1.0 (-1.7 to -0.3)	-1.4 (-1.6 to -1.3)	-0.8 (-1.0 to -0.6)	1.9	No
WBC	6.66 (6.52 to 6.81)	6.58 (6.43 to 6.73)	6.51 (6.36 to 6.65)	2.4	6.2 (3.4 to 9.0)	2.7 (2.1 to 3.3)	0.5 (-0.5 to 1.5)	7.1	No
HCT	39.90 (39.62 to 40.18)	40.01 (39.72 to 40.30)	40.28 (40.00 to 40.55)	0.9	-0.6 (-1.4 to 0.3)	-1.1 (-1.2 to -0.9)	-0.5 (-0.8 to -0.2)	1.9	No
Lymphocyte (%)	31.24 (30.60 to 31.89)	33.04 (32.36 to 33.72)	33.30 (32.67 to 33.94)	6.2	-9.2 (-12.1 to -6.4)	-7.8 (-8.3 to -7.3)	-0.6 (-1.6 to 0.4)	7.5	No
Neutrophil (absolute count)	4.00 (3.86 to 4.14)	3.82 (3.67 to 3.97)	3.76 (3.62 to 3.89)	6.4	12.1 (7.2 to 17.0)	8.2 (7.1 to 9.3)	1.9 (-0.0 to 3.9)	8.8	No
Monocyte	7.79 (7.64 to 7.95)	7.79 (7.63 to 7.95)	7.66 (7.51 to 7.81)	1.7	0.0 (-3.1 to 3.1)	1.1 (0.6 to 1.7)	1.4 (0.2 to 2.6)	9.1	No
MCH	30.43 (30.31 to 30.55)	30.49 (30.36 to 30.62)	30.56 (30.44 to 30.68)	0.4	-0.2 (-0.6 to 0.3)	-0.3 (-0.4 to -0.2)	-0.2 (-0.4 to -0.0)	0.9	No
MCHC	33.05 (32.98 to 33.12)	33.16 (33.09 to 33.24)	33.21 (33.14 to 33.28)	0.5	-0.3 (-0.6 to -0.1)	-0.5 (-0.5 to -0.4)	-0.1 (-0.2 to 0.0)	0.6	No
RBC count	4.35 (4.32 to 4.38)	4.37 (4.34 to 4.41)	4.40 (4.36 to 4.43)	1.0	-0.6 (-1.6 to 0.3)	-1.2 (-1.4 to -1.1)	-0.4 (-0.7 to -0.1)	2.0	No
RDW	12.98 (12.89 to 13.07)	12.97 (12.88 to 13.07)	12.96 (12.87 to 13.05)	0.1	1.0 (-0.0 to 2.0)	0.0 (-0.2 to 0.2)	-0.1 (-0.5 to 0.3)	1.3	No
PDW	11.22 (11.11 to 11.34)	11.10 (10.98 to 11.22)	10.99 (10.87 to 11.10)	2.2	0.8 (-0.2 to 1.7)	2.5 (2.3 to 2.7)	1.1 (0.7 to 1.5)	3.2	No
Eosinophil	2.60 (2.44 to 2.76)	2.80 (2.63 to 2.97)	2.79 (2.64 to 2.95)	7.0	-6.9 (-15.4 to 1.7)	-8.7 (-10.2 to -7.3)	-1.5 (-4.8 to 1.8)	14.9	No
PLT	248.80 (244.61 to 252.99)	247.22 (242.86 to 251.57)	246.58 (242.42 to 250.73)	0.9	1.8 (-0.1 to 3.7)	1.5 (1.1 to 2.0)	0.3 (-0.4 to 1.0)	5.5	No
Basophil	0.49 (0.47 to 0.51)	0.50 (0.48 to 0.52)	0.50 (0.48 to 0.52)	2.3	-1.8 (-8.3 to 4.7)	-2.2 (-3.3 to -1.1)	0.2 (-4.8 to 5.1)	9.1	No
PT %	96.63 (95.65 to 97.61)	96.68 (95.48 to 97.89)	96.01 (95.06 to 96.97)	0.7	-1.3 (-3.1 to 0.5)	0.5 (-0.1 to 1.1)	-0.3 (-2.7 to 2.1)	NA	No
PT INR	1.05 (1.03 to 1.06)	1.05 (1.03 to 1.06)	1.05 (1.04 to 1.06)	0.6	1.4 (-0.2 to 3.1)	-0.2 (-0.9 to 0.5)	-0.1 (-3.4 to 3.2)	NA	No
PT sec	13.24 (13.13 to 13.36)	13.24 (13.10 to 13.38)	13.30 (13.19 to 13.41)	0.4	1.0 (-0.1 to 2.1)	-0.1 (-0.6 to 0.4)	0.1 (-2.2 to 2.4)	1.8	No
Kidney function and electrolytes									
BUN	15.84 (15.39 to 16.29)	15.79 (15.33 to 16.26)	15.60 (15.16 to 16.05)	1.5	-0.1 (-3.4 to 3.1)	1.3 (0.6 to 1.9)	-0.3 (-1.4 to 0.8)	8.4	No
Sodium	140.12 (139.89 to 140.35)	140.32 (140.08 to 140.55)	140.31 (140.09 to 140.54)	0.1	-0.2 (-0.4 to -0.1)	-0.2 (-0.2 to -0.2)	0.0 (-0.1 to 0.1)	0.3	No
Potassium	4.35 (4.31 to 4.38)	4.39 (4.36 to 4.43)	4.40 (4.37 to 4.44)	1.3	-0.6 (-1.5 to 0.2)	-1.1 (-1.3 to -0.9)	-0.1 (-0.4 to 0.2)	2.5	No
Cl	103.65 (103.40 to 103.90)	103.97 (103.71 to 104.23)	103.79 (103.54 to 104.04)	0.3	-0.5 (-0.7 to -0.2)	-0.2 (-0.3 to -0.2)	0.1 (0.0 to 0.2)	0.6	No
Uric acid	5.18 (5.07 to 5.29)	5.19 (5.07 to 5.31)	5.21 (5.10 to 5.32)	0.6	0.5 (-3.1 to 4.0)	-0.8 (-1.3 to -0.3)	-0.5 (-1.3 to 0.4)	6.3	No
Calcium, total	9.46 (9.40 to 9.52)	9.45 (9.39 to 9.51)	9.53 (9.47 to 9.58)	0.8	0.8 (-1.1 to 2.6)	-0.7 (-0.9 to -0.4)	-0.7 (-1.1 to -0.2)	1.1	No
Liver function									
AST	25.48 (24.07 to 26.89)	24.46 (23.01 to 25.92)	25.34 (23.95 to 26.74)	4.2	1.0 (-7.1 to 9.1)	2.4 (0.8 to 4.0)	-0.1 (-2.7 to 2.5)	6.2	No
ALT	24.08 (22.29 to 25.87)	22.10 (20.26 to 23.94)	24.07 (22.30 to 25.84)	8.9	-0.6 (-9.3 to 8.1)	3.8 (1.6 to 5.9)	0.6 (-2.9 to 4.1)	9.3	No
Bilirubin, total	0.54 (0.51 to 0.57)	0.62 (0.58 to 0.65)	0.63 (0.60 to 0.67)	14.8	-15.0 (-21.2 to -8.8)	-17.0 (-18.2 to -15.9)	-3.2 (-6.5 to 0.1)	12.3	Yes
Albumin	4.39 (4.37 to 4.42)	4.39 (4.36 to 4.41)	4.42 (4.39 to 4.44)	0.7	-0.5 (-1.3 to 0.3)	-0.3 (-0.5 to -0.2)	-0.3 (-0.5 to 0.0)	1.7	No
Protein	7.00 (6.97 to 7.04)	7.01 (6.98 to 7.05)	7.07 (7.04 to 7.10)	1.0	-0.3 (-1.0 to 0.5)	-0.9 (-1.1 to -0.8)	-0.6 (-0.9 to -0.4)	1.7	No

(continued)

Table 2. Adjusted Means by Fasting Duration and Within-Person Differences for Representative Routine Analytes by Fasting Duration, Compared With Analytical Performance Specifications (continued)

Analyte	Adjusted mean (95% CI) ^a			Max diff, % ^b	Within-person difference, % (95% CI) ^c			EFLM, % ^d	Exceeds EFLM ^e
	<8 h	8 to 12 h	>12 h		<8 h vs 8 to 12 h	<8 h vs >12 h	8 to 12 h vs >12 h		
GGT	66.28 (58.81 to 73.74)	56.89 (49.52 to 64.26)	59.39 (52.29 to 66.49)	16.5	21.7 (−15.4 to 58.8)	14.8 (3.9 to 25.7)	0.9 (−5.4 to 7.3)	9.2	Yes
LDH	213.86 (205.69 to 222.02)	208.66 (199.80 to 217.51)	206.09 (198.28 to 213.90)	3.8	NA	0.6 (−2.2 to 3.4)	1.4 (−2.2 to 5.1)	3.4	Yes ^f
Pancreatic enzymes									
Amylase	74.87 (69.37 to 80.37)	69.55 (63.48 to 75.61)	72.20 (67.05 to 77.35)	7.7	NA	4.6 (0.2 to 8.9)	−1.1 (−5.7 to 3.6)	6.5	Yes ^f
Lipase	58.38 (51.45 to 65.30)	48.07 (40.64 to 55.51)	49.61 (43.59 to 55.62)	21.4	NA	36.4 (15.7 to 57.1)	0.5 (−11.9 to 12.9)	6.3	Yes
Lipid profile									
Cholesterol	168.47 (165.43 to 171.50)	166.60 (163.49 to 169.71)	170.78 (167.78 to 173.79)	2.4	−0.3 (−2.0 to 1.4)	−1.3 (−1.7 to −1.0)	−0.3 (−0.8 to 0.3)	4.3	No
Triglyceride	150.41 (142.21 to 158.61)	118.33 (110.03 to 126.62)	126.09 (118.11 to 134.07)	27.1	17.1 (5.5 to 28.7)	20.1 (17.4 to 22.8)	2.4 (0.1 to 4.6)	13.2	Yes
HDL-cholesterol	54.65 (53.29 to 56.01)	56.12 (54.76 to 57.49)	56.17 (54.85 to 57.50)	2.7	−1.6 (−4.3 to 1.1)	−2.7 (−3.4 to −1.9)	−1.2 (−1.8 to −0.5)	5.3	No
LDL-cholesterol (direct method)	105.80 (102.10 to 109.51)	97.69 (93.86 to 101.52)	105.25 (101.68 to 108.82)	8.3	−3.2 (−11.6 to 5.1)	−0.4 (−2.1 to 1.2)	−0.5 (−2.5 to 1.5)	6.2	Yes ^f
Glucose and diabetes									
Glucose	120.75 (118.27 to 123.24)	111.87 (109.32 to 114.42)	111.88 (109.43 to 114.34)	7.9	13.0 (9.5 to 16.6)	10.8 (10.0 to 11.6)	−0.7 (−1.4 to 0.0)	3.1	Yes
HbA _{1c} (IFCC)	48.12 (47.25 to 49.00)	48.28 (47.40 to 49.17)	47.96 (47.14 to 48.78)	0.7	1.6 (−1.5 to 4.7)	2.2 (1.1 to 3.3)	0.2 (−0.5 to 0.9)	1.6	No
Hormones									
T3	1.02 (1.00 to 1.04)	1.06 (1.03 to 1.09)	1.06 (1.04 to 1.08)	4.1	NA	−2.5 (−5.4 to 0.4)	0.4 (−4.5 to 5.3)	4.3	No
Others									
25-(OH) vitamin D, total	21.55 (19.34 to 23.76)	23.01 (20.21 to 25.81)	23.93 (21.82 to 26.03)	9.9	NA	−9.9 (−14.4 to −5.4)	−3.3 (−12.1 to 5.5)	6.7	Yes

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; BUN, blood urea nitrogen; EFLM, European Federation of Clinical Chemistry and Laboratory Medicine; GGT, γ-glutamyl transferase; HB, hemoglobin; HbA_{1c}, glycated hemoglobin; HCT, hematocrit; HDL, high-density lipoprotein; IFCC, International Federation of Clinical Chemistry and Laboratory Medicine; INR, international normalized ratio; LDL, low-density lipoprotein; LDH, lactate dehydrogenase; Max diff, maximum difference; applicable; PDW, platelet distribution width; PLT, platelet count; PT, prothrombin time; RBC, red blood cell; RDW, red cell distribution width; T3, triiodothyronine; WBC, white blood cell count; 25-(OH) Vitamin D, 25-hydroxyvitamin D.

SI conversion factors: To convert HB, MCHC, albumin, and protein from g/dL to g/L, multiply by 10; absolute counts of WBC, lymphocytes, neutrophils, eosinophils, and basophils to ×10⁹ per liter, multiply by 0.001; % of HCT and monocyte to proportion of 1.0, multiply by 0.01; sodium and potassium from mEq/L to mmol/L, multiply by 1.0; AST, ALT, GGT, LDH, amylase, and lipase from U/L to μkat/L, multiply by 0.0167; total cholesterol, HDL-C, and LDL-C from mg/dL to mmol/L, multiply by 0.0259; T3 from pg/dL to pmol/L, multiply by 0.0154; 25 (OH) vitamin D from ng/mL to nmol/L, multiply by 2.496; triglyceride from mg/dL to mmol/L, multiply by 0.0113; glucose from mg/dL to mmol/L, multiply by 0.0555; percentage of total HbA_{1c} to proportion of total HbA_{1c}, multiply by 0.01; total bilirubin from mg/dL to mmol/L, multiply by 17.104; uric acid from mg/dL to mmol/L, multiply by 0.0595; total calcium from mg/dL to

mmol/L, multiply by 0.25; CI from mg/dL to mg/L, multiply by 10.

^a Adjusted means (in conventional units) were estimated from linear mixed-effects models with a random intercept for patient, adjusted for age, sex, and ordering department.

^b Maximum value of percentage difference between less than 8 hours, 8 to 12 hours, and more than 12 hours of fasting duration.

^c Within-person differences were estimated from paired comparisons within the same patient across visits with different fasting durations and are expressed as percentages relative to the mean of the reference (latter) group among paired patients.

^d Optimal analytical performance specification derived from biological variation (EFLM Biological Variation Database) total allowable error.

^e “Exceeds EFLM” indicates the maximum percentage difference exceeded the optimal analytical performance specification derived from biological variation (EFLM Biological Variation Database).

^f The maximum percentage difference exceeded the EFLM specification in the between-group comparison, but the corresponding within-person difference (<8 hours vs >12 hours) showed no meaningful difference, indicating the apparent difference was not confirmed within the same patients and was likely attributable to between-group confounding.

(95% CI, 3.9 to 4.7), declining from 134.0 mg/dL at 0.5 hours to 113.3 mg/dL at 4 hours (−15.4%), beyond which values were similar; this exceeded its specification of 3.1%. Adjusted lactate was 27.9% lower over the same interval, for which no EFLM specification is available. Lipid components (total cholesterol, high-density lipoprotein [HDL-C], low-density lipoprotein [LDL-C], and triglycerides) showed no significant short-term trend within this window (eTable 4 in Supplement 1).

Discussion

In this large clinical dataset, fasting duration was associated with differences exceeding analytical performance specifications for 27 of 121 routine analytes in between-group comparisons, but only 10 were reproduced when the same patients were compared across visits, chiefly analytes with recognized

Table 3. Laboratory Tests Showing Linear Associations With Fasting Duration Within the Subgroup Fasting Less Than 8 Hours

Test item	Difference per additional hour of fasting (95% CI) ^a	% Difference, 0.5 h vs 4 h after last meal ^b	EFLM optimal TEa (%) ^c
Glucose, mg/dL	-4.273 (-4.67 to -3.87)	-15.4	3.1
Lactate, whole blood, mmol/L	-0.059 (-0.07 to -0.04)	-27.9	NA
AST, U/L	0.276 (0.12 to 0.43)	0.8	6.2
Total protein, g/dL	0.033 (0.03 to 0.04)	1.3	1.7
Albumin, g/dL	0.025 (0.02 to 0.03)	1.6	1.7
Potassium, mmol/L	0.008 (0.006 to 0.011)	0.7	2.5
Hemoglobin, g/dL	0.045 (0.03 to 0.06)	0.8	1.9
Hematocrit, %	0.158 (0.12 to 0.20)	1.0	1.9
RBC, 10 ⁶ /μL	0.019 (0.01 to 0.02)	1.2	2.0
Platelet, 10 ³ /μL	1.101 (0.48 to 1.72)	0.2	5.5
WBC, 10 ³ /μL	0.083 (0.06 to 0.10)	0.0	7.1
Neutrophil, absolute, 10 ³ /μL	0.048 (0.03 to 0.07)	-3.7	8.8
Eosinophil, %	-0.047 (-0.07 to -0.03)	-0.4	14.9
Basophil, %	-0.007 (-0.01 to -0.00)	-0.2	9.1
Prothrombin time, s	-0.022 (-0.04 to -0.01)	-0.7	1.8

Abbreviations: AST, aspartate aminotransferase; EFLM, European Federation of Clinical Chemistry and Laboratory Medicine; RBC, red blood cell count; TEa, allowable total error; WBC, white blood cell count.

^a Estimates were obtained from linear regression models with fasting duration modeled continuously and adjusted for age, sex, and ordering department. Only analytes meeting the prespecified threshold for a linear trend ($P < .001$) are shown.

^b Difference between the adjusted means at 0.5 and 4 hours after the last meal (eTable 4 in Supplement 1), expressed as a percentage of the value at 0.5 hours. Because fasting time is modeled categorically for these estimates, the direction of this contrast may differ from the linear slope.

^c Optimal analytical performance specification derived from biological variation (EFLM Biological Variation Database).

postprandial physiology (glucose, triglycerides, GGT, and lipase), together with total bilirubin and 25-hydroxyvitamin D, which were higher after prolonged fasting. For most routine tests, including the complete blood count, electrolytes, kidney and liver function tests, and total and HDL-C, differences were within the specification or were not confirmed within individuals. The principal strengths of this analysis are its scale, the breadth of analytes examined, and the availability of paired within-person comparisons.

Prior evidence has been dominated by lipids. Sidhu and Naugler, studying more than 200 000 individuals, reported that total cholesterol and HDL-C varied by less than 2% across fasting times, LDL-C by up to 10%, and triglycerides by up to 20%.¹⁰ Our findings are consistent with theirs and extend them by showing, within individuals, that fasting beyond 12 hours did not meaningfully alter lipid measurements relative to 8-12 hours. Comparable data for liver, pancreatic, and hematologic analytes have been sparse, and time-resolved postprandial data beyond glucose and triglycerides have been largely unavailable, while the present analysis provides both.

Our results revealed a hierarchy of fasting sensitivity among different analytes. Adjusted values for glucose were lower by approximately 4.3 mg/dL per additional hour of fasting (from 134.0 mg/dL at 0.5 hours to 113.3 mg/dL at 4 hours; Table 3). This confirms that traditional 8-hour or more fasting requirements remain necessary for accurate fasting glucose measurements and diabetes screening. This finding aligns with established physiological understanding of postprandial glucose metabolism. Lactate showed an even larger short-term difference, approximately 27.9% lower by 4 hours (Table 3). This likely reflects the transient rise in blood lactate shortly after a meal,

which then clears over a few hours. Although no EFLM TEa was available for lactate, these results indicate that recent intake is associated with substantially higher lactate.

Lipid profiles showed intermediate sensitivity. Triglycerides were higher with shorter fasting (within-person <8 h vs >12 h, 20.1%), which is consistent with post-meal increases Sidhu et al¹⁰ noted for non-fasting triglycerides. Total cholesterol and HDL-C differed no more than 3%, consistent with previous findings and within acceptable clinical variation. GGT was also higher with shorter fasting and exceeded the specification, a previously underreported observation. Pancreatic enzymes (lipase and, more modestly, amylase) were higher with shorter fasting as well, consistent with postprandial digestive enzyme release, although the small number of paired patients warrants caution in interpreting these findings.

A notable finding was the discordance between the between-group and within-person analyses for several analytes. In the between-group comparisons, LDL cholesterol, T3, LDH, and some liver-related enzymes appeared to be higher after prolonged fasting, suggesting a possible paradoxical association with extended fasting duration. However, these differences were not reproduced within individuals, suggesting that the apparent between-group differences reflected between-person confounding rather than a direct effect of prolonged fasting. The small differences in leukocyte subsets are similarly difficult to separate from the well-described diurnal variation in these cells, because shorter-fasting samples are necessarily drawn later in the day.

The within-person analysis also revealed a few signals absent between groups. Glycated albumin (3.8%) and hemoglobin A_{1c} (2.2%) were slightly higher at shorter fasting

despite no between-group difference. Because these are cumulative indices of glycation formed over weeks to months, neither can change acutely with a single fasting interval, and the fact that 2 markers with different half-lives moved together indicates a genuine difference in the patients' underlying glycemic status between visits rather than a fasting effect, most likely because shorter-fasting samples more often accompany unscheduled or follow-up visits during periods of poorer control. Consistent with this, both were null in the comparison between 8 to 12 hours vs more than 12 hours, and the effect was clinically trivial (hemoglobin A_{1c}, approximately 48 to 49 mmol/mol). These signals illustrate that within-person comparisons, while removing stable between-patient confounding, cannot fully eliminate time-varying confounding related to the clinical context of testing and should not be interpreted as genuine fasting effects.

Limitations

This study has several limitations. First, the data come from a single secondary-care hospital in Korea and are restricted to outpatient phlebotomy. This approach may introduce biases related to specific patient demographics, institutional clinical practices, and laboratory methodologies that could limit generalizability. Second, we did not evaluate how often a fasting-related difference would move a result across a clinically meaningful decision threshold, for example, a fasting glucose crossing a diagnostic cutpoint or an LDL-C crossing a treatment target. Because the differences were small for most analytes, such reclassification was probably uncommon, but its frequency cannot be inferred from mean differences and may be greater for values lying near a threshold. Third, the retrospective nature also prevented us from controlling meal composition or verifying patient-reported fasting times. Macro-nutrient composition, and not fasting duration alone, may influence several analytes, and because habitual diets differ across populations, the magnitude of the postprandial differences reported here may not generalize to other settings. Fourth, fasting duration was recorded only when at least one test explicitly requiring fasting (eg, glucose or lipid profile) was concurrently ordered. Consequently, nonfasting-specific analytes such as ferritin or thyroid function tests were included in our analysis only when they were co-ordered with a fasting-required test, which may have introduced selection bias. Fifth,

although within-person comparisons remove stable between-patient confounders, they do not remove time-varying confounders such as time of day, intercurrent illness, or medication changes between visits. Finally, the study sample skewed toward older adults (median age, 61 years [IQR, 49-73]), and because the postprandial response can differ by age and sex, including menopausal status, applicability to younger adults such as premenopausal women is uncertain. Prospective, multicenter studies with standardized protocols would be valuable to confirm and extend these findings across diverse populations and health care settings. Comparison with population-representative datasets such as the Korea National Health and Nutrition Examination Survey (KNHANES) could further clarify how our estimates relate to the general Korean population, although differences in sampling protocols and assay methods would need to be reconciled.³²

Conclusions

Our comprehensive analysis suggests that most routine blood tests are minimally affected by short-term fasting and fasting beyond 12 hours was not associated with meaningful additional differences for any test examined. Shorter fasting periods are associated with minimal differences in most analytes except glucose, triglycerides, GGT and pancreatic enzymes, supporting more flexible testing protocols for many clinical situations. The lipid and liver-enzyme elevations with prolonged fasting seen between groups were not confirmed within individuals and likely reflected confounding.

These findings suggest that traditional rigid fasting requirements may warrant reconsideration in favor of a more nuanced, analyte-specific approach to pretest preparation. Adequate fasting (≥ 8 hours) should be maintained when glucose or precise lipid measurement is the goal, whereas greater flexibility may be reasonable for many other routine tests. Prolonged fasting beyond 12 hours conferred no measurable advantage for any analyte, including triglycerides, and represents an avoidable burden for patients. If confirmed by prospective multicenter studies, this analyte-specific approach could reduce patient burden while maintaining test accuracy. Clinicians should be aware that results from very short fasting may require careful interpretation for a limited set of postprandial-sensitive analytes.

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