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Automated process assessment of primary healthcare for hyperlipidemia: preliminary findings and implications form Anhui, China

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Abstract

Background Primary healthcare (PHC) plays a key role in hyperlipidemia (HL) management yet lacks adequate monitoring and feedback. This study aims at identifying pragmatic measures out from routinely collected electronic records to enable automatic monitoring and inform continuous optimization of HL-management at PHC settings.

Methods The study used randomly selected electronic records of PHC (from the province-wide data center of Anhui-province, China) as the main data source and generated both procedure-based and encounter-based measures for assessing HL-management. The procedure-based measures were derived from specific quality-facts of 21 stages/procedures (e.g., lipid lowering medication prescription) using self-designed algorithms. While the encounter-based measures included number or rate of visits for HL, currently-noticed hyperlipidemia (CNHL, or HL noticed during the current consultation), and ever-diagnosed hyperlipidemia (EDHL). Analysis of these measures employed mainly simple descriptives and linear regression modeling.

Results The study revealed interesting findings including: low and varied rates of visits for HL(from 0.01 to 1.43%) and visits by patients with EDHL/CNHL(from 0.13 to 20.54% or from 0.02 to 2.99%) between regions; large differences (5.14 to 22.20 times) between the mean or cumulative proportions of visits by patients with EDHL versus CNHL among clinician groups; consistent increase in the ratio of visits for HL in all cause visits over the study period (from 0.087 to 1.000%) accompanied with relatively stable proportions of patients with CNHL/EDHL; Relatively low scores in the procedure-based measures (ranged from 0.00 to 36.08% for specific procedures by seasons).

Conclusions The measures identified are not only feasible from real-world PHC records but also give some useful metrics about how well current HL-management is going and what future actions are needed.

Keywords Hyperlipidemia, Measures, Primary health care, Automatic monitoring, China

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Introduction

Hyperlipidemia (HL), including hypercholesterolemia, hypertriglyceridemia, mixed hyperlipidemia, and high-density lipoproteinemia, is prevalent worldwide [1]. According to a WHO report, in 2008, the global prevalence of elevated plasma total cholesterol among adults aged 25 years and older was 39% [2]. HL is the main risk factor for chronic cardiovascular disease [3]. Elevated low-density lipoprotein cholesterol is the second leading metabolic risk factor for cardiovascular disease mortality worldwide, following only hypertension [4]. HL-management stresses sustained cholesterol control. However, cholesterol treatment and control rates remain suboptimal, being estimated as 54.1% and 35.7% in the United States [5], 58.1% and 42.3% in Brazil [6], 40.3% and 29.7% in Germany [7], 7.2% and 4.1% in India [8], and 3.9%% and 0.6% in Russia [9]. In China, studies suggest that the prevalence of dyslipidemia among adults aged 18 and older is as high as 40.4%, with approximately 100 million requiring cholesterol-lowering treatment [10]. However, 36.0% residents with HL are unaware of their cholesterol status [11]. The treatment rate is only 5.5% among high-risk patients (10-year risk for arteriosclerotic cardiovascular disease ≥ 10%) and 14.5% among patients with very high risk (patients already had stroke or myocardial infarction) [12]. Reasons underlying the above low rates are complex, involving both residents and health systems. Most residents are unaware of the importance of monitoring their lipid [13, 14]; while those who have already been diagnosed with HL often lack the necessary knowledge, attitude and skills in managing the condition [15, 16]. For health systems, primary healthcare (PHC) plays a key role in HL-management since it not only provides the bulk of HL-related services [17, 18], but also has unique and irreplaceable advantages in accessing and identifying at risk residents and promoting continued case management. To help PHC practitioners fully realize their potentials, more and more countries (including China) have developed guidelines on HL-management. However, adherence to these guidelines is low [19–21]. Systematic reviews suggest that guideline implementation faces various barriers, including lack of awareness and familiarity, lack of agreement and self-efficacy, lack of outcome expectancy, the inertia of previous practice, and external barriers such as time limitations and absence of a reminder system [22, 23]. Almost all of these barriers can be traced via PHC records and record-based audit and feedback have been shown to be effective in improving both the process of clinical care and outcomes [24, 25]. However, traditional audit practices rely on expert panels and lack cost-effectiveness and scalability. This study aims to identify pragmatic measures from routinely collected electronic records suitable to be incorporated with existing health information systems to enable automatic monitoring of compliance with guidelines and inform continuous optimization of PHC for HL-management.

Methods

Development of measures

The study developed both procedure-based and encounter-based measures for assessing HL-management process at PHC settings. Development of the procedure-based measures used only records of consultations with hyperlipidemia as the primary or first diagnosis and proceeded in 4 steps. Step 1 divided a typical episode of consultation for HL into four stages, namely, symptoms and history, tests and examinations, diagnosis and treatment, and education and counselling. Step 2 identified essential procedures for each of the stages. Step 3 checked, via consensus meetings of experts, for quality facts for each of the procedures against relevant guidelines [26, 27]. Step 4 calculated, using self-designed formulas, quality scores for each of the procedures identified in step 3 (17 procedure-scores in total) and the stages identified in step 2 (4 stage-scores). For more information about the quality facts and formulas, please refer to Appendix 1.

The encounter-based measures were based on whether HL was diagnosed or noticed in the consultation record, including: number of visits for HL, rate of visit for HL, ever-diagnosed HL and currently-noticed HL (Table 1).

Data sources and content

This study used data from two separate sources. The majority of data were extracted from the electronic records of PHC stored at the province-wide data center of Anhui, a province with 60 million people in China. The records included patient's sex, age, presentations of current illness, disease history and diagnosis and

Table 1 Definition of encounter-based measures of primary healthcare for hyperlipidemia (HL)

Name of measure	Definition of measure
Number of visits for HL	Episodes of visits to primary healthcare settings with HL being recorded as the first or primary diagnosis.
Rate of visit for HL	Number of visits for HL per 100 population under concern, e.g., per 100 residents, per 100 visits for all health conditions.
Ever-diagnosed HL (EDHL)	A patient was viewed as a patient with EDHL if any of his/her electronic records in the study period had indication that he/she had been diagnosed with HL. Suppose a patient had visited primary healthcare settings 3 times in the study period. If any of the 3 records had indication that he/she had been diagnosed with HL, then he/she was a patient with EDHL.
Currently-noticed HL (CNHL)	A visit was viewed as a visit with CNHL if the record had mentioned HL as eighter a cause/comorbidity for the current visit or as a past disease history.

prescription given by the attendant clinician (a sample record in English was given in Appendix 2). The record extraction adopted a stratified random cluster sampling proceeded in the following steps: inclusion of all the administrative regions ($n = 16$) and counties/cities ($n = 104$) within Anhui Province; random selection of 1 community from each of the 104 counties/cities; and extraction of all the electronic records entered by the PHC providers in the selected communities from November 2019 (when the province-wide data center had brought into full use) to December 2021 (when this data extraction took place). In total, 7924 providers were included in the study and 6.09 million records of PHC visits were extracted including 227,616 visits by patients with ever-diagnosed HL. The study also extracted data about population size by sex and age groups from the Annual Statistical Reports of Health in Anhui Province 2021 [28].

Data process and analysis

The extracted records were processed by: classifying the free text diagnoses into HL, HT (hypertension), DB (diabetes), GT (gastritis) and others; and checking and valuing the quality facts (yes = 1, no = 0). Both the classification of diagnoses and checking of quality facts used Microsoft SQL Server 2008R2 and algorithms verified through rounds of refinement. For any given item (GI) of diagnoses or facts, the refinement proceeded as: (a) a first data-analyst developed an SQL algorithm and used it in labeling the GI as either 1 (yes) or 0 (no); (b) a second data-analyst randomly selected 200 records with GI = 1 and another 200 records with GI = 0 from all the labeled records; (c) the second data-analyst sent the sampled records to two experienced PHC clinicians to check the sensitivity and specificity of the GI values; (d) if the sensitivity and specificity fell below preset standard (95%), the results together with reasons for the mistakes were feedback to the first data-analyst to refine the algorithm and then repeat steps a to d until the preset standards had met. This process took a total of 8 weeks. The first data-analyst took about 3 weeks in developing a separate algorithm for each item listed in Appendix 1, while the iterative refinement process lasted for 5 weeks.

Analysis of the procedure-based and encounter-based measures employed mainly simple descriptives and linear regression modeling. We estimated number and rates of visits for HL and rates of ever-diagnosed and currently-noticed HL among residents and patients of all causes or indicative diseases and by time, clinicians and regions. Indicative diseases included hypertension (HT), diabetes (DB) and gastritis (GT). Of these, HT and DB were included due to their strong association with HL in terms of shared risk factors, complications and methods for case management [29, 30]. GT was selected as an indicative disease since the consultation for GT also provide a unique opportunity for promoting HL-management suck as diet modifications [31]. To facilitate comparisons of patterns of variations or trend across subgroups, we calculated the following for part of the measures: unified ratios, univariate linear regression parameters (coefficients, constants and p values), variation coefficients (VC), cumulative or unified ratios/proportions. Univariate linear regression modeling was used to detect whether there was a statistically significant trend ($p < 0.05$) between the dependent and independent variables. We also calculated procedure and stage quality scores by months using the formulas as defined in Appendix 1. The findings were presented in 5 compositive figures consisting of topographies, bars, lines and graded circles.

Results

HL-related visits by regions

Figure 1 (and Appendix 3) shows the rates of visits for HL and rates of visits by patients with currently-noticed or ever-diagnosed HL by the 16 regions of Anhui. All these indicators varied substantially across the regions. The rates of visits for HL ranged from 0.01 to 1.43 per 100 population (mean = 0.34%, VC = 97.13%); while the rates of visits with ever-diagnosed or currently-noticed HL, from 0.13 to 20.54% (mean = 6.76%, VC = 84.95%) or from 0.02 to 2.99% (mean = 1.21%, VC = 75.30%). Regional variations in the rates of visits with ever-diagnosed or currently-noticed HL by the indicative diagnoses were also substantial, ranging from 0.03 to 7.93% (mean = 3.37%, VC = 74.76%) or from 0.00 to 0.65% (mean = 0.14%, VC = 112.04%) for GT, from 0.88 to 15.20% (mean = 5.74%, VC = 66.97%) or from 0.00 to 1.17% (mean = 0.48%, VC = 69.02%) for DB and from 0.06 to 15.17% (mean = 6.07%, VC = 71.72%) or from 0.01 to 2.01% (mean = 0.56%, VC = 87.16%) for HT. The rate of ever-diagnosed HL among visits for GT tended to be greater in regions with higher rate of visits for the same diagnose. A similar association was observed for DB but a reverse relationship for HT.

HL-related visits by time

Figure 2 (and Appendix 4) displays proportion or number of HL-related visits among patients of all causes and the 3 indicative diseases by months in the study period. The unified ratio of visits due to HL displayed substantial increase over the study period (being 0.145 per population or 0.087 per all-cause visit in month 0 compared with 1 in month 25); while both the proportions of patients with currently-noticed and ever-diagnosed HL among all patients remained relatively stable. For the 3 indicative diagnoses (Fig. 2b-d), the mean proportion of visits with currently-noticed HL in visits due to DB

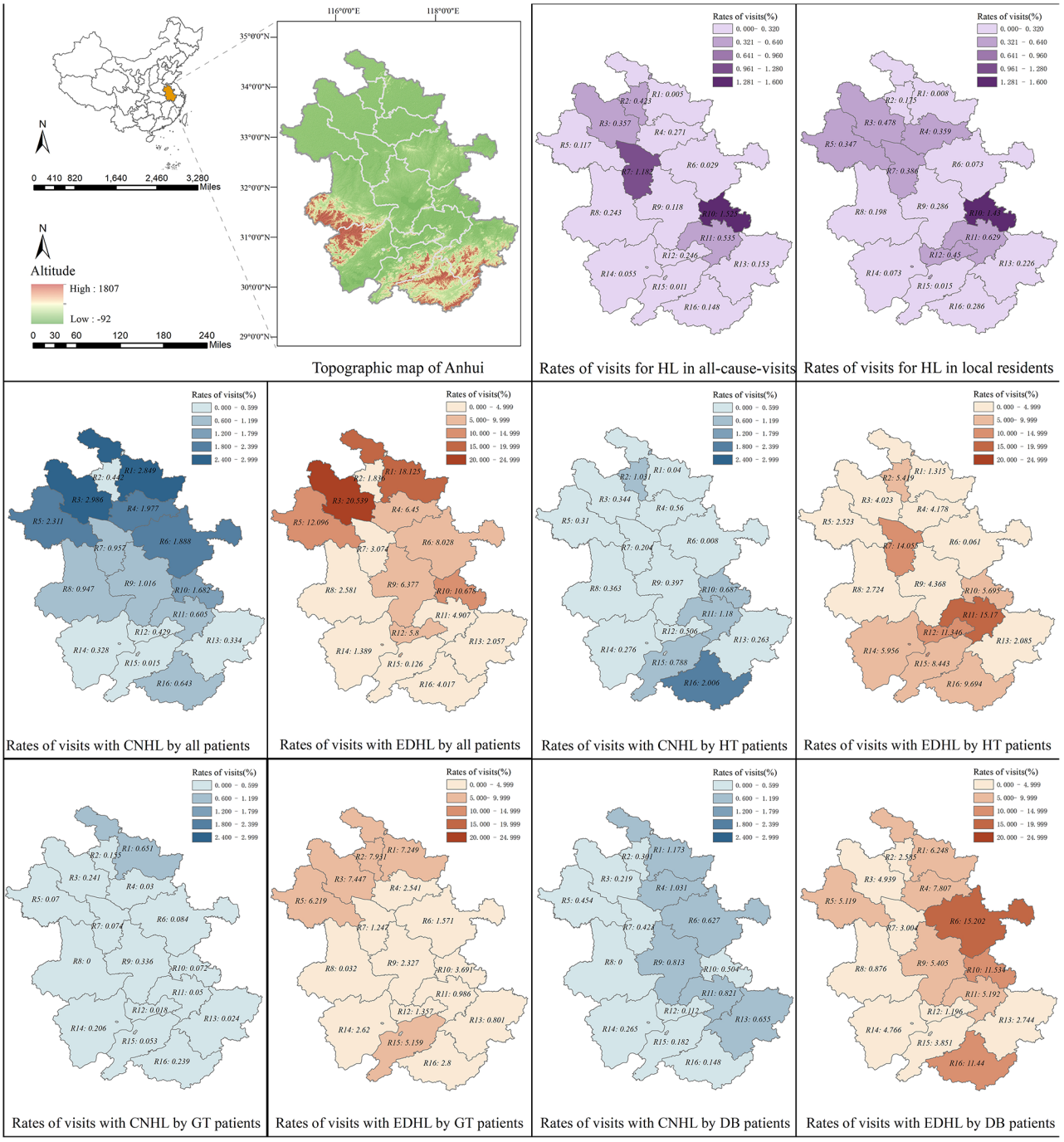

Fig. 1 Hyperlipidemia-related visits by regions. Note HL, HT, GT and DB stand for hyperlipidemia, hypertension, gastritis and diabetes respectively; EDHL and CNHL denote ever-diagnosed and currently-noticed hyperlipidemia; R1 through to R16 denote the 16 regions in Anhui province, China

was the highest (0.67%), followed by HT (0.59%) and GT (0.24%). In comparison, the proportions of patients with ever-diagnosed HL were much greater but in a similar order, being 6.70%, 5.89%, and 4.28% in DB, HT and GT patients respectively. Neither the monthly proportions of visits with currently-noticed nor those with ever-diagnosed HL for any of the 3 indicative diagnoses showed clear increasing or decreasing trend.

HL-related visits by patients

Figure 3 (and Appendix 5) portraits the rates of currently-noticed and ever-diagnosed HL by sex, age and indicative diagnoses. For all cause patients (Fig. 3a), the rates of visits for HL by age-groups displayed a general parabolical pattern, starting at 0.02% (or 0.02%) for males (or females) in the under-25 group, peaking at 0.83% (or 1.26%) around the age of 61–65 and declining to 0.34%

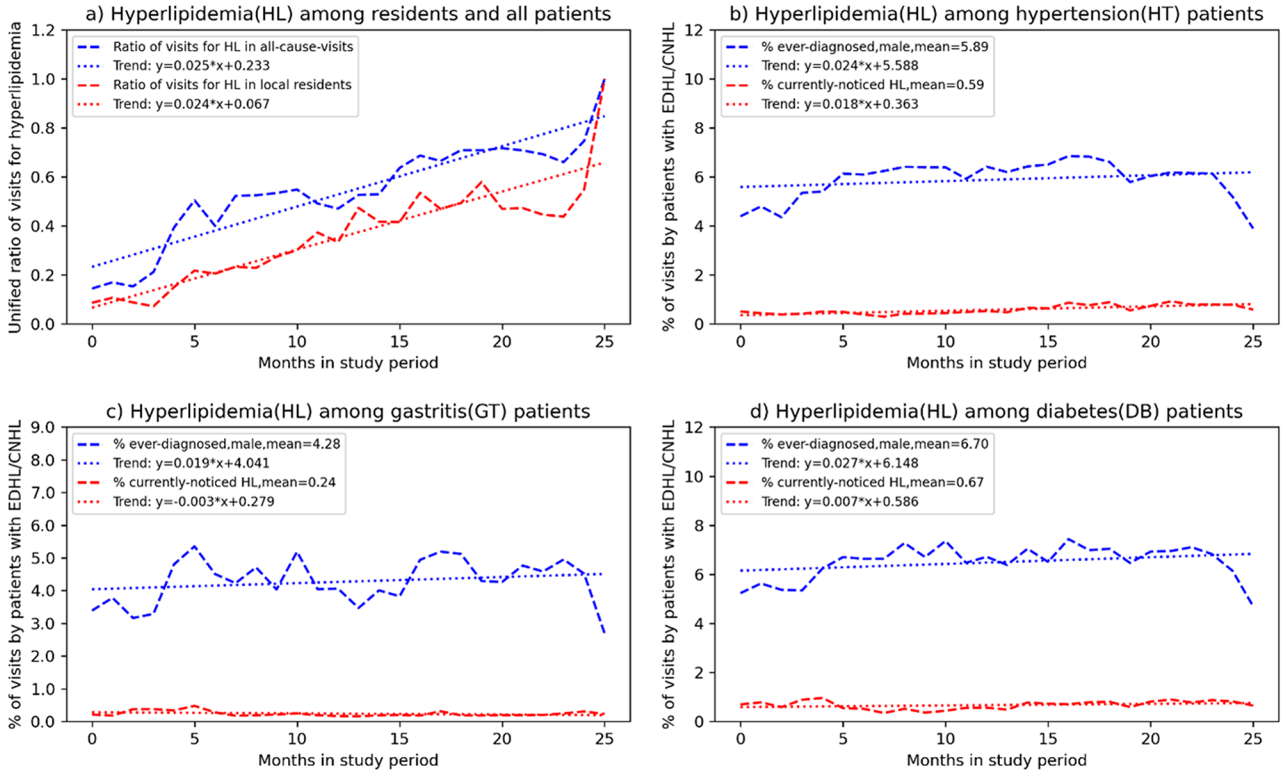

Fig. 2 Hyperlipidemia-related visits by time. Note HL, HT, GT and DB stand for hyperlipidemia, hypertension, gastritis and diabetes respectively; EDHL and CNHL denote ever-diagnosed and currently-noticed hyperlipidemia

(or 0.23%) by 85 and above. Both the proportions of patients with currently-noticed and ever-diagnosed HL by age-groups presented a steadily increasing trend and a rapidly growing gap between the two kinds of proportions. The proportion of ever-diagnosed HL was 4.22 (or 4.19) times that of currently-noticed HL for the under-25 age group but 4.62 (or 4.76) times for the 85 + age group. All the three kinds of proportions by age groups manifested a X-shaped sex differences, being higher for males than females before 51–55 years but the opposite after that age-group. For patients with HT, GT and DB (Fig. 3b-d), similar age- and sex-related trends and gaps were also observable. In addition, the cumulative proportion (CP) of currently-noticed HL along age groups was 10.72 (or 11.88) for all patients, 3.17 (or 2.51) for GT patients, 8.01 (or 7.47) for HT patients, and 8.20 (or 8.39) for DB patients, while the CP of ever-noticed HL was 55.10 (or 65.00) for all patients, 47.21 (or 55.73) for GT patients, 62.28 (or 70.48) for HT patients, and 74.20 (or 72.94) for DB patients.

HL-related visits by clinicians

Figure 4 (and Appendix 6) presents HL-related visits by clinicians with different service volumes. Among all cause visits, the proportion of currently-noticed HL remained relatively stable along the groups of clinicians with greater and greater service volumes, while the proportion of ever-diagnosed HL showed an apparent increasing trend, resulting in a growing gap between the proportions of ever-diagnosed versus currently-noticed HL. The modeled difference between the proportions was 1.84% for the bottom group to 4.23% for the top group of clinicians. Similar trends were also observed for the 3 indicative diagnoses, with DB witnessed the biggest difference between the proportions of ever-diagnosed versus currently-noticed HL (difference in CP = 86.75), followed by HT (difference in CP = 84.49) and GT (difference in CP = 59.99).

Scores of HL consultations

Figure 5 (and Appendix 7) describes sores of consultation procedures for HL by seasons derived using SQL algorithms. Given the approaches employed in developing the procedure-based measures as described in the methods section and the scoring formula as specified in Appendix 1, the scores should range from 0.00 to 100%, with higher scores reflecting better guideline compliance. Among the four main constructs of procedures assessed, diagnosis and treatment scored the highest on average (mean = 26.73%), followed by symptoms and history (10.37%), education and counselling (6.12%) and tests and examinations (0.79%). For detailed measures

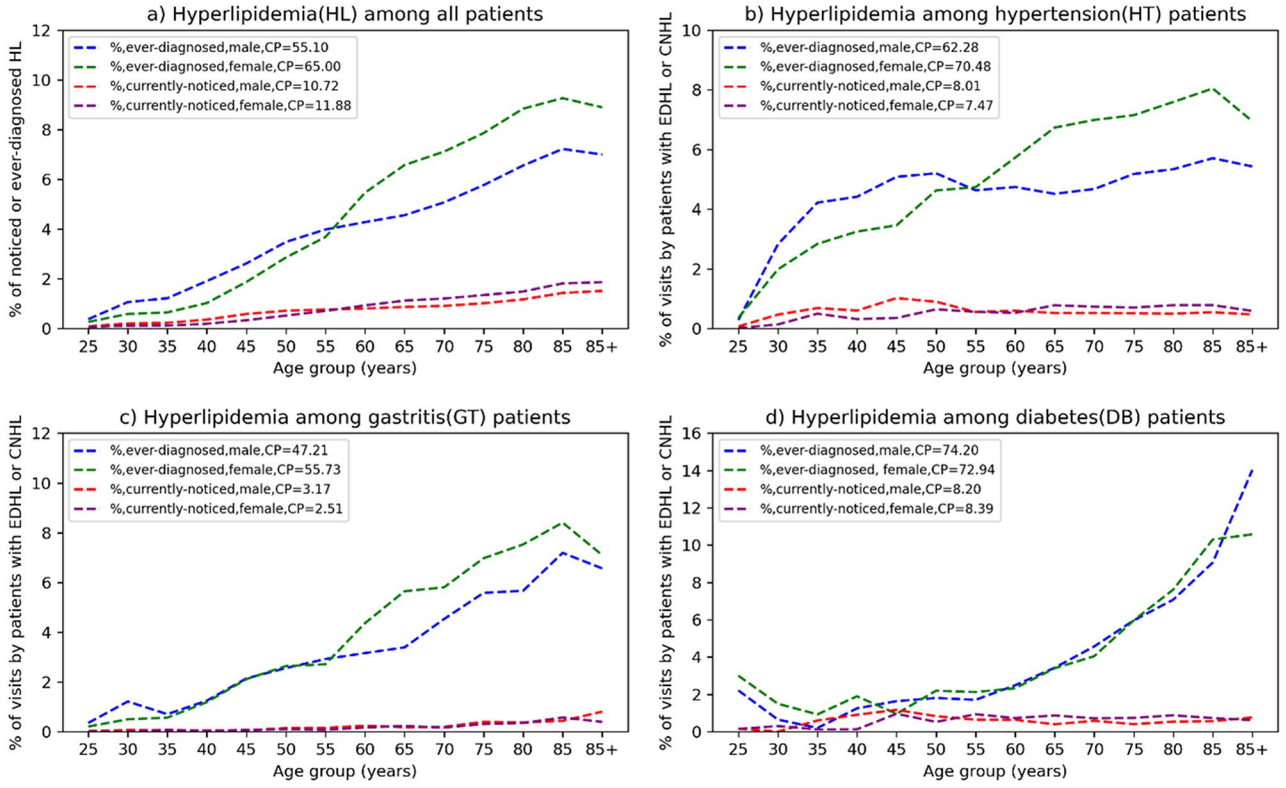

Fig. 3 Hyperlipidemia-related visits by patients. Note HL, HT, GT and DB stand for hyperlipidemia, hypertension, gastritis and diabetes respectively; CP denotes cumulative proportion over age-groups

listed under the four constructs, lipid-lowering drugs scored the highest (29.99%), followed by complication diagnosis (29.08%), comorbidity diagnosis (28.88%), and medication instructions (18.86%). Most of the measures witnessed some extent of increases during the 8 seasons studied. For instance, the scores for reported symptoms increased from 22.41% in the Winter of 2020 to 30.36% in the Autum of 2021. No clear seasonal variations were observed in all the scores.

Discussion

Principle findings

This study identified a set of encounter-based and procedure-based measures from routinely collected electronic records suitable to be incorporated with existing health information systems. The study also tested the feasibility of these measures and uncovered informative findings for future practice and research. These findings include: (a) low and varied proportions of visits for HL and visits by patients with EDHL or CNHL; (b) substantial differences between the proportions of visits by patients with EDHL and CNHL which increased rapidly along groups of patients with older-and-older age and clinicians with larger-and-larger service volume; (c) apparent increase in the ratio of visits for HL in all cause visits over the study period accompanied with relatively stable proportions of patients with currently-noticed and ever-diagnosed HL; (d) large gaps between the procedures actually recorded and that recommended by the national guidelines.

Explanations and implications

The descriptive statistics and models as presented in Fig. 1 portrait a general profile of HL-related PHC by regions. These findings can help answer a number of general yet prerequisite questions such as: how high is the uptake of PHC for HL in a given region as compared with other areas, published estimates, or recommended standards; how big is the gap between recorded visits with EDHL and CNHL between different regions and diseases; to what extent the visits for HL and by patients with EDHL/CNHL vary among different regions and which regions have the greatest potential for improvement. Taking the example of Anhui, the descriptives suggest that underdiagnosis of HL and underuse of PHC for HL were common since the rate of visits for HL in over two years ranged from 0.06 to 0.41%, being much lower than the estimated prevalence rate of HL in Anhui (30.5%) and other areas (32.21-49.3%) [32–36]. The lines from our linear regression modeling in the figure suggest that additional efforts are needed to promote PHC for HL, particularly in southern Anhui, where the proportions of visits by patients with EDHL/CNHL were lower

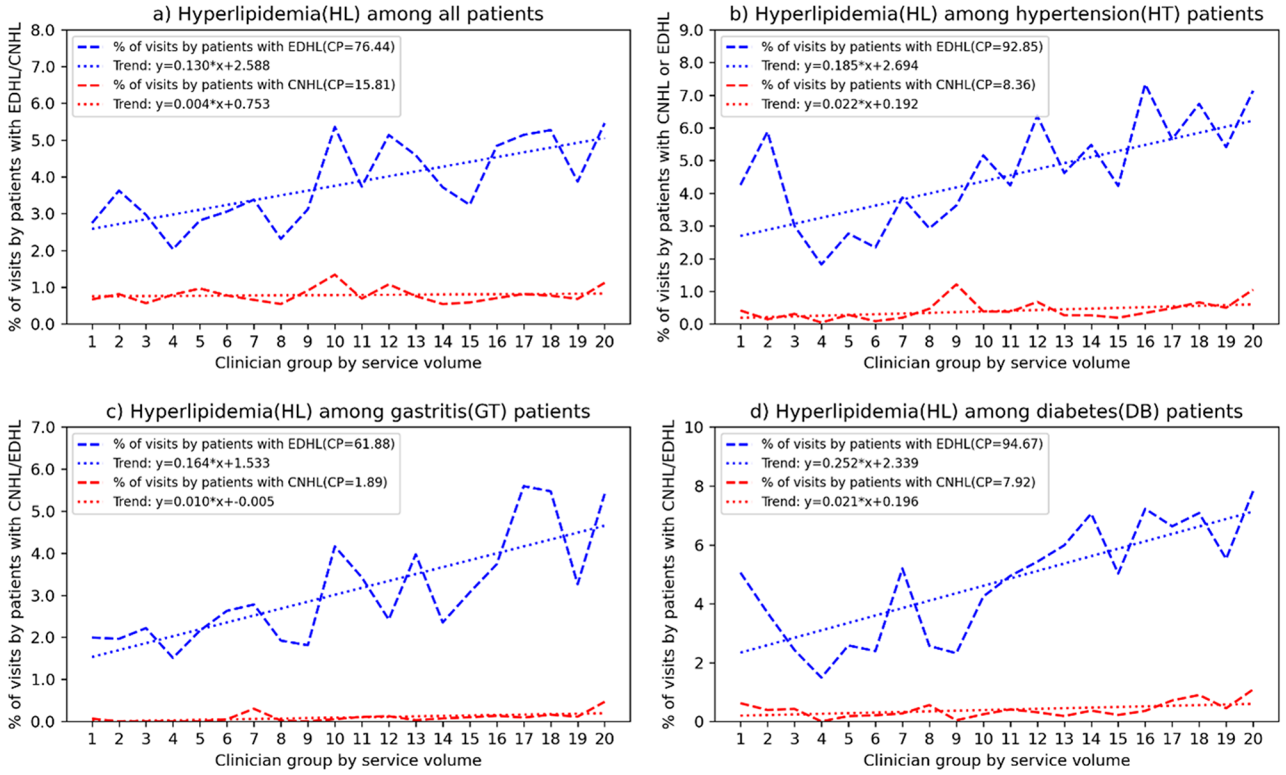

Fig. 4 Hyperlipidemia-related visits by clinicians. Note HL, HT, GT and DB stand for hyperlipidemia, hypertension, gastritis and diabetes respectively; EDHL and CNHL denote ever-diagnosed and currently-noticed hyperlipidemia; CP denotes cumulative proportion over clinician groups

Quality Indicators	Winter 1 (%)	Spring 1 (%)	Summer 1 (%)	Autumn 1 (%)	Winter 2 (%)	Spring 2 (%)	Summer 2 (%)	Autumn 2 (%)
Symptoms and history	8.49	7.43	10.90	12.06	10.87	10.65	10.87	11.65
Reported symptoms	22.41	20.02	31.34	33.07	29.17	28.08	27.63	30.36
Disease history	4.78	4.45	6.46	6.87	6.59	6.65	7.04	7.39
Related behaviors	2.88	2.89	5.28	5.83	4.87	4.36	4.34	4.48
Healthcare use	10.34	8.78	12.05	13.46	11.34	11.51	10.57	11.53
Family history	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tests and examinations	0.34	0.42	1.04	0.76	0.87	0.91	1.02	0.94
Body signs of ilness	10.55	8.46	10.30	13.10	13.25	13.31	15.68	16.14
Blood lipid test	1.27	1.76	4.93	3.44	4.03	4.19	4.72	4.30
Liver function test	0.01	0.04	0.05	0.03	0.00	0.04	0.04	0.08
Other lab tests	0.00	0.01	0.02	0.01	0.00	0.01	0.01	0.03
Diagnosis and treatment	21.03	20.90	27.34	27.77	28.23	28.21	29.76	30.58
Hyperlipidemia diagnosis	6.76	7.59	11.24	9.83	12.07	12.33	13.28	13.33
Comorbidity diagnosis	21.52	20.60	31.13	31.97	31.44	30.84	31.20	32.36
Complication diagnosis	21.73	20.78	31.31	32.17	31.64	31.06	31.42	32.54
Lipidlowering drugs	27.78	27.51	26.98	27.48	28.61	30.19	35.30	36.08
Other medications	6.08	7.63	5.28	5.81	6.31	6.14	6.76	6.62
Education and counseling	2.77	3.57	5.49	7.27	6.76	6.97	7.74	8.41
Medication instructions	10.65	11.52	17.55	20.85	20.53	21.17	23.66	24.98
Lifestyle modifications	0.31	1.68	2.44	4.94	3.73	3.77	3.34	4.34
Referral assistance	0.03	0.32	0.37	0.60	0.56	0.65	0.61	0.74
Follow-up planning	0.09	0.75	1.61	2.69	2.22	2.30	3.36	3.59

Fig. 5 Quality sores of consultations for hyperlipidemia by seasons. Note The scores were based only on records of consultations with hyperlipidemia as the primary or first diagnosis

than in northern regions. The geographical difference may partly be explained by the fact that as the landscape changes from plateau areas in the north to mountainous areas in the south, the time needed to access PHC settings increases gradually [37, 38].

The findings as presented in Fig. 2 should inform actions in response to temporal trends in visits for HL and by patients with EDHL/CNHL. Rates fluctuating around or converging toward desirable levels can be encouraged; otherwise, actions for reversing the trend are needed. As indicated by the linear regression analysis, visits for HL and by patients with EDHL/CNHL in Anhui witnessed moderate to major increases over the months studied. This may be viewed as a positive trend thought the absolute rates were still substantially lower than estimations according the national guidelines by the end of the study period [39]. Visits for a disease in a given time period reflects the joint effects of the prevalence and provision and uptake of healthcare for the disease. So, trends or fluctuations along time-axis should signal further examinations of rather than directly identifying specific causes or factors. Being a chronic condition, the prevalence of HL should be relatively stable and 2 years may be too short to observe major changes, while provision and uptake of healthcare for HL may be easier to witness short-term variations. Given these, the increases may be attributed more to short- than long-term factors, like the outbreak of COVID-19 pandemic, structural changes. In the past years, Anhui and China have launched various initiatives in controlling major chronic diseases, including public awareness raising and publication and promotion of the national guideline on HL-management at PHC settings (version 2019) [40, 41]. However, the gap between visits by patients with EDHL and CNHL remained almost unchanged in the same period, suggesting that these efforts had been focused primarily on visits caused mainly by HL, with little attention on incorporating HL-management into routine consultations for other conditions like diabetes, hypertension and gastritis.

The descriptives as presented in Fig. 3 should inform differentiated strategies to improve HL-management by patient-groups, such as identifying when and for whom HL screening and intervention should be prioritized. The lowered and parabolical form of the rates of visits for HL observed in Anhui call for added efforts in increasing provision and uptake of the service for all age-groups with particular attention being paid on maintaining use of HL-related PHC for those older than the turning group (61–65 years). Studies have shown that HL prevalence increased along the ages until some 70 years and remained relatively high thereafter. By comparison, the visit rate for HL in Anhui decreased from 1.04% for the 61–65 years to 0.28% for the 85 + years [42–44]. The growing gap between the ratios of visits by patient with EDHL and CNHL calls for increasing attention along the age-groups on identifying and addressing potential comorbidity of HL in consultations for non-HL conditions. Similarly, the x-shaped sex differences in the ratios of HL-related visits by age groups suggest a need of further studies for underlying reasons and potential interventions leveraging the differences, especially initiatives for females aged around the crossing point (51–55 years), into better HL prevention and management.

The results as presented in Fig. 4 should facilitate prioritization of clinician-groups for enhancing HL-management. The majority of visits for HL in Anhui were attended by the last few groups (e.g., groups 20, 19, 18 and 17) of clinicians. This suggests that, especially when faced with resource limits, clinicians with top service volumes should be the first to be trained and monitored to improve HL-management. In addition, the upward trend as shown by the regression models suggest that clinicians with greater and greater service volumes were associated with larger and larger gap between the proportions of patients with ENHL and CNHL. This positive association may be explained mainly by two inter-related factors: (a) clinicians with greater service volume or popularity are generally busier and thus faced with higher time pressure in addressing comorbidities [45, 46]; and (b) more popular clinicians tend to attract more sophisticated patients (including patients with comorbidities) [47, 48]. The associations also support the use of service volume as a criterion in selecting priority clinicians for interventions incorporating HL-management with consultations for other conditions, especially diabetes, hypertension and gastritis.

The scores as summarized in Fig. 5 portrait a performance profile of consultations for HL in the past seasons. All scores - scores were designed from 0.00 to 100%, with a higher score standing for better guideline compliance in terms of collecting the history, ordering the test, prescribing the lipid-lowering drugs etc. Yet all the measures were assessed lower than 37% in Anhui. One of the reasons underlying such low scores may be that most clinicians at PHC settings lacked adequate awareness and/or familiarity of the newly published guidelines on HL-management in China [22]. Another reason may be inertia of previous practice in which the clinicians were used to short consultations (within a few minutes), focusing primarily on making diagnoses and prescribing [49, 50]. Other reasons may include: incomplete recording of primary healthcare encounters [51, 52]; short of time, equipment and other resources [53]; insufficient supervision and technical support [54, 55]; inadequate even inverse incentives [56, 57]. Given these, there is a clear need for improving the consultation procedures for HL and regular feedback of the scores at a reasonable interval (e.g., every 3 months) accompanied with a convincing

and actionable summary of features and justifications of the scores and future actions to enhance the scores may prove to be an effective way leveraging continuous improvement. An example of such summary for the scores in Fig. 5 was given in Appendix 8.

The procedure- and encounter-based measures tried in Anhui can be implemented in other provinces and countries. Any area with centralized operating electronic record systems should satisfy the hardware and software requirements for computing and using the measures. The diagnosis and control standards and guidelines on lipid-lowering drugs and lifestyle modifications between China that by international agencies (e.g., the World Health Organization) and developed countries are almost the same. So, the specific items selected for assessing the process quality in the current study may be applied in most areas with minimum adaptation. In terms of validation, this study suggests that the measures have reasonable feasibility, accuracy and specificity. As for usefulness or efficacy, it merits to be further studied. Various strategies may be used to realize the benefits of the measures. One way in reaching this end may be using the assessment from these measures to inform policy-making and planning of continuous education initiatives for clinicians at PHC settings. Another way may be establishing a disease-specific performance appraisal mechanism on base of these and other measures. A third way may be performing regular (e.g., semi-annual or seasonal) assessment of HL-management using the measures and filing actionable feedback reports like Appendix 8 to relevant clinicians and administrators.

Strengths and limitations

The study has both strengths and limitations. It is advantageous since: (a) it used large-scale and representative electronic records spanning 25 months for an entire province in China; (b) it identified pragmatic measures for monitoring and improving real-world consultations for HL at primary health care settings; (c) it revealed useful clues for future interventions and research. Limitations of the study include: (a) the findings were heavily dependent on the quality of the PHC records and readers are cautioned about potential biases due to incomplete, inaccurate and inconsistent recording; (b) the study period was relatively short (25-months), longer timeframe (say 5 or 10 years) will allow more detailed and reliable analysis of tends and cyclical patterns; (c) the study focused primarily on procedures of HL-related consultations but made no efforts in examining the health outcomes of the service, e.g., occurrence and consequences of HL-related complications. In addition, the rate of visits to PHC settings by local residents in China may underestimate the actual level of healthcare use for two reasons. First, residents (especially those living in rural areas) often become transient workers in cities. Second, unlike western developed countries, China lacks strict referral system in which patients can freely choose any healthcare-givers at any levels without a referral letter. As a result, transient workers often seek healthcare in cities rather than their local communities. Fortunately, visit by all-cause visits may be used as a surrogate or complementary measure of visits by local residents given the social-structural contexts like China.

Conclusions

The measures identified in this study are feasible from routinely collected electronic records and suitable to be incorporated with existing health information systems to inform continuous optimization of HL-management at PHC settings. There is a clear need to improve the provision and uptake of PHC for HL in Anhui, China.

Abbreviations

PHC	Primary healthcare
HL	Hyperlipidemia
CNHL	Currently-noticed hyperlipidemia
EDHL	Ever-diagnosed hyperlipidemia
HT	Hypertension
DB	Diabetes
GT	Gastritis
GI	Given item
VC	Variation coefficients
CP	Cumulative proportion

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12944-025-02435-7.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

Supplementary Material 6

Supplementary Material 7

Supplementary Material 8

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Author contributions

D. W. conceived the study. N. Y. and Y. W. did the statistical analysis and drafted the first version of the manuscript. X. S. was the principal investigator of the funding project. Y. L., D. X., R. C., N. L., R. L. and J. C. contributed to interpretation of findings and critically revised the manuscript. All authors approved the final version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The electronic records of primary healthcare encounters used in this study were all desensitized aggregate data extracted from the electronic medical record data center in Anhui province and none of the research team had access to information that could identify individual participants. So, patient informed consent was not required or provided. Yet formal ethical approval of the study was obtained from the Biomedical Research Ethics Committee of Anhui Medical University (No. 83230511).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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