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Original Research Article

Detecting GLP-1 agonist misuse and counterfeit penetration in Iraq: A triangulated early-warning framework

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Abstract

Purpose: *To develop an early-warning pharmacovigilance framework that triangulates adverse drug reaction (ADR) reports, internet search data and substandard and falsified (SF) medicine alerts, using glucagon-like peptide-1 (GLP-1) receptor agonists in Iraq as a case study.*
Methods: *GLP-1 individual case safety reports (ICSRs) from the Iraqi Pharmacovigilance Center (IPhVC) VigiFlow database, Google Trends relative search volume (RSV, a 0 to 100 index of search popularity) for English and Arabic GLP-1 terms with metformin as control, and IPhVC SF alerts were analyzed retrospectively. Within-database observed-to-expected (O/E) ratios with 95 % confidence intervals (CI) were calculated for four System Organ Classes (SOCs) of the Medical Dictionary for Regulatory Activities (MedDRA). Lagged Spearman correlations (0 – 3 months).*
Results: *The database held 41 GLP-1 ICSRs by December 2024; 18 (44 %) were submitted in 2024 and 14 (34 %) were serious. The O/E ratio for injury, poisoning and procedural complications was 3.2 (95 % CI 1.7 – 5.8). Inter-coder agreement was substantial (κ = 0.78). Of 11 ICSRs that mentioned counterfeit, online or unlicensed supply, 7 (64 %) fell within ± 1 month of an SF alert for the same brand. RSV for "Mounjaro" preceded ICSRs by 1 – 2 months (ρ = 0.31 – 0.42). Counterfeit oral tirzepatide capsules and sprays appeared on social media by 2025.*
Conclusion: *The framework yields hypothesis-generating signals from three routinely available data sources, which in Iraq converged on GLP-1 misuse and counterfeit supply. The approach may be adapted by pharmacovigilance centers in other low- and middle-income countries (LMICs).*

Keywords: *Falsified medicines, GLP-1 receptor agonists, Google Trends, Pharmacovigilance, Semaglutide, Signal detection, Tirzepatide*

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INTRODUCTION

Glucagon-like peptide-1 (GLP-1) receptor agonists, together with the dual glucose-dependent insulinotropic polypeptide (GIP)/GLP-1 receptor agonist tirzepatide, have changed the treatment of type 2 diabetes mellitus and obesity [1,2]. Demand for weight loss has outpaced supply even in high-income countries, leading to shortages, compounded products, and online sales without a prescription [3,4]. In 2024, the World Health Organization (WHO) warned that falsified semaglutide was circulating in several regions [5]. The risk is probably greater in low- and middle-income countries (LMICs), where regulatory and post-marketing surveillance capacity is still developing and substandard and falsified (SF) medicines are more common [6].

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Iraq has a formal national pharmacovigilance program and joined the WHO Programme for International Drug Monitoring in 2010 [7,8]. The Iraqi Pharmacovigilance Center (IPhVC) receives individual case safety reports (ICSRs), each describing a suspected adverse reaction in one patient to one or more medicines, through VigiFlow, and keeps a national register of SF medicine alerts [8,9]. Reactions in ICSRs are coded with the Medical Dictionary for Regulatory Activities (MedDRA), a hierarchical terminology in which every term sits under a System Organ Class (SOC) such as gastrointestinal disorders [11]. In 2024, an IPhVC bulletin described three parallel warnings for GLP-1 products: rising public interest on Google Trends, a small cluster of adverse drug reaction (ADR) reports and several SF alerts involving Ozempic®, Saxenda® and unregistered Mounjaro® [10].

That descriptive work did not link the three data sources formally. Disproportionality methods are rarely applied to small databases, Google Trends is often used without control terms or lag analysis, and ICSR narratives are seldom coded with reported inter-rater agreement. The aim of this study was to develop a reproducible triangulation framework for early-warning pharmacovigilance in LMICs and test it on GLP-1 receptor agonists in Iraq.

METHODS

Study design

A retrospective, descriptive, multi-source analysis of routinely collected pharmacovigilance data and publicly available search data was conducted at the IPhVC, Baghdad. Three independent data streams were used, covering January 2024 (or the first available record) to December 2025. Figure 1 shows the framework: the three streams, the analytical steps applied to each and the combined signal outputs.

Pharmacovigilance reports

The IPhVC manages the Iraqi VigiFlow database, the WHO web-based system that national centers use to record ICSRs and transmit them to VigiBase, the global database maintained by the Uppsala Monitoring Centre (UMC) [12]. The national database is not publicly accessible. Access was obtained through the IPhVC under institutional authorization, and only de-identified records were extracted.

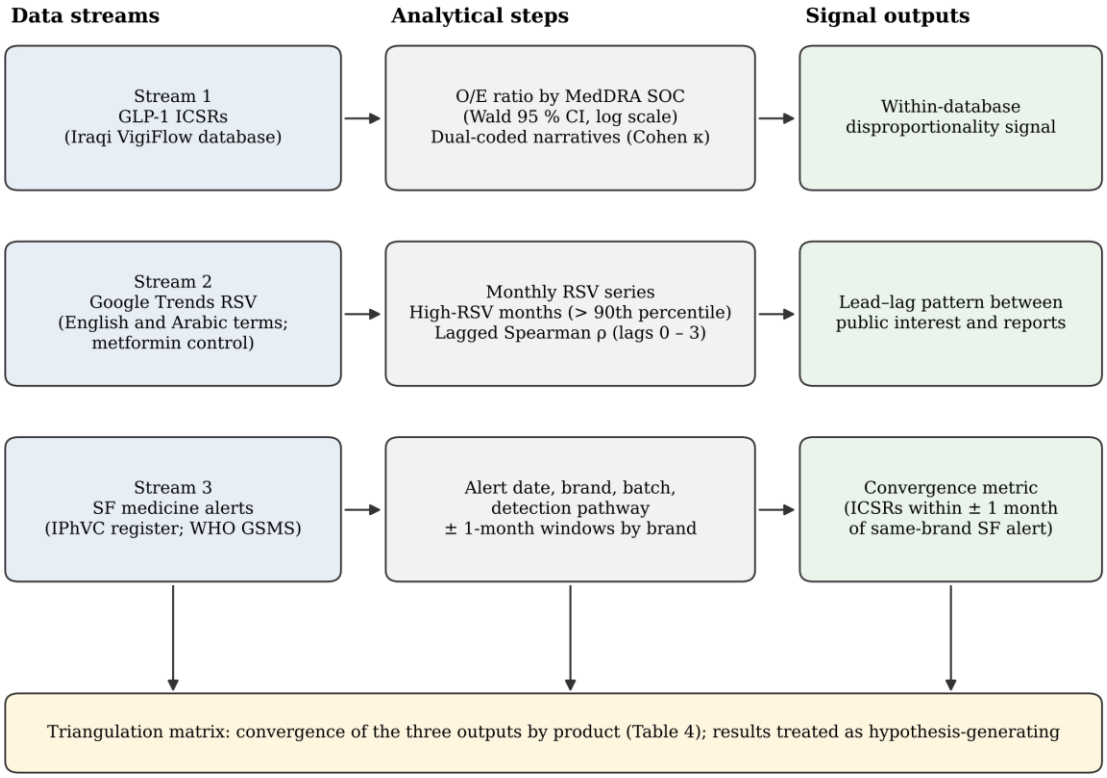

Figure 1: Schematic of the triangulation framework. ICSR, individual case safety report; RSV, relative search volume; SF, substandard and falsified; IPhVC, Iraqi Pharmacovigilance Center; GSMS, Global Surveillance and Monitoring System; O/E, observed-to-expected; SOC, System Organ Class

The database was searched for all ICSRs in which liraglutide (Saxenda®, Victoza®), semaglutide (Ozempic®, Wegovy®) or tirzepatide (Mounjaro®) was recorded as a suspected, interacting, or concomitant medicine. Narratives were reviewed manually to exclude unrelated agents and duplicates. Extracted variables were age, sex, reporter qualification, WHO seriousness criteria, MedDRA Preferred Terms (PTs), outcome, preventability, narrative text, and product identifiers. When an IPhVC record was incomplete, the Iraqi subset of VigiBase was consulted under the UMC conditions that apply to national centers [12].

Google Trends data

Google Trends (https://trends.google.com) reports relative search volume (RSV), the share of all searches in a region and period that contain a given term, scaled from 0 to 100, where 100 marks the period of peak interest [13]. Queries were run with the location set to Iraq, the period January 2024 to December 2025, monthly resolution, the “All categories” filter and “Web search”, following an established methodology framework [13]. Search terms were the brand names Ozempic (أوزمبيك), Mounjaro (مونجارو), Saxenda (ساكسيندا) and Wegovy (ويغوفي), entered in English and in Arabic transliteration, the molecule name semaglutide, and the safety terms side effects (آثار جانبية) and dangers (أضرار). Metformin (ميتفورمين) served as the control term because it is a widely used antidiabetic medicine with no cosmetic demand. The outputs analyzed were monthly RSV series, interest by governorate and the top twenty-five related queries for each term.

Substandard and falsified medicine alerts

The national SF register, kept by the IPhVC since 2016, was reviewed for every alert concerning a GLP-1 receptor agonist or a product sold under a GLP-1 brand name. Abstracted variables were alert date, product name, batch or lot number, nature of the defect, stated country of origin, detection pathway (patient report, inspectorate seizure, online surveillance, or laboratory analysis) and any documented harm. Alerts that Iraq shared with the WHO Global Surveillance and Monitoring System (GSMS) were cross-checked for consistency.

Observed-to-expected ratios

The small number of GLP-1 ICSRs did not allow a formal disproportionality analysis against the whole of VigiBase. A within-database O/E ratio, structured like the proportional reporting ratio [13], was therefore calculated for each SOC. This was the proportion of GLP-1 ICSRs coded to that SOC divided by the same proportion among non-GLP-1 Iraqi ICSRs from the same period. The 95 % confidence interval was estimated with the Wald method on the log scale. An O/E ratio above 1 with lower CI b(CI) bound above 1 was taken as within data base signal that needed further evaluation.

Four of the 27 MedDRA SOCs were selected on clinical and methodological grounds instead of screening all of them, since assessing every SOC with only forty-one reports would have produced many chance findings. Injury, poisoning, and procedural complications were the primary SOCs, because MedDRA codes medication errors, off-label use, and administration of counterfeit product under this class, which makes it the closest match to the misuse construct. Gastrointestinal disorders acted as a positive control, as these events reflect the known pharmacology of the class [1]. Psychiatric disorders and metabolism and nutrition disorders were secondary SOCs, chosen because depression and hypoglycemia were among the PTs reported for GLP-1 products.

Time-lagged correlations

Monthly counts of GLP-1 ICSRs and GLP-1 SF alerts, and monthly RSV for each term, were assembled for the analysis window. Spearman rank correlations were calculated for each pair of series at lags of 0, 1, 2, and 3 months; a positive lag from RSV to ICSRs means that public interest came before reporting. Bootstrap 95 % CI were obtained from 1,000 resamples. No correction for multiple comparisons was applied, so the correlations were treated as exploratory.

Triangulation matrix and convergence metric

A month was labeled a high-RSV month for a term if its RSV was above the 90th percentile of that term's distribution over the study period. For each high-RSV month, ICSRs and SF alerts naming the same brand within ± 1 month were counted. The primary convergence metric was the proportion of ICSRs whose narratives mentioned "counterfeit", "online" or "unlicensed" supply that fell within ± 1 month of an SF alert of the same brand.

Narrative coding

Two pharmacists independently coded ICSR narratives, one from the Medical City Directorate

and the other from the Iraqi Pharmacovigilance Center, Ministry of Health. They used five categories defined before coding and based on the 2024 bulletin [9]. These categories include: cosmetic or non-medical off-label use; procurement through unlicensed online or social media sources; dosing or titration error; exposure during pregnancy; and suspected counterfeit or unauthorized product. Agreement was measured with Cohen's κ [14]. Disagreements were settled by discussion, when needed, by a third reviewer.

Ethical approval

The study protocol was approved by the Scientific and Ethics Committee of the College of Pharmacy, University of Baghdad (approval no: RECAUBCPO23047A, April 15th 2026). Only anonymized pharmacovigilance records and public Google Trends data were used, and no patient-identifiable information was accessed or reported. VigiBase data were handled according to UMC policy, and the work followed the Declaration of Helsinki [16].

RESULTS

Regulatory context

In January 2025, three medicines were authorized in Iraq for the management of obesity: orlistat 120 mg, liraglutide 6 mg/ml prefilled pen and semaglutide 2.27 mg/ml and 3.2 mg/ml injections [10]. Table 1 separates formal authorization from actual market availability for the main GLP-1 brands. This gap between authorization and availability is itself a likely driver of demand for unauthorized or counterfeit products.

Profile of GLP-1 adverse drug reaction reports

By December 2024, the Iraqi database contained 41 GLP-1 ICSRs, of which 18 (44 %) were submitted during 2024 [9]. Reporters included pharmacists, physicians, other health professionals, and patients; across the national database, pharmacists submitted 79 % of all 2024 reports. Fourteen cases (34 %) met at least one WHO seriousness criterion. Gastrointestinal disorders appeared in 23 ICSRs (56 %), mostly nausea, vomiting, abdominal pain, abdominal distension, dyspepsia, constipation, and diarrhea. Injury, poisoning, and procedural complications appeared in 11 ICSRs (27 %), including dosing errors (mainly omitted titration), off-label use, use without a prescription, exposure during pregnancy and administration of counterfeit product. Other PTs were headache, depression, hypoglycemia (usually with concomitant insulin or a sulfonylurea) and injection-site rash.

The O/E ratio for injury, poisoning and procedural complications was 3.2 (95 % CI 1.7 – 5.8), the only SOC whose lower bound exceeded 1 (Table 2). Gastrointestinal disorders showed a small elevation, consistent with the known pharmacology, while the two secondary SOCs did not. Mounjaro® appeared in about one-fifth of GLP-1 ICSRs, although it is not authorized in Iraq, which points to an unregulated supply chain. Saxenda® had the largest share of branded reports, followed by Ozempic® and Victoza®.

Table 1: Authorization status, market availability, and labeled dosing of GLP-1 receptor agonists in Iraq (end of 2024) [9,17-20]

Brand	Active ingredient	First approval (FDA; EMA)	Iraq authorization*	Marketed in Iraq	Labeled dosing
Saxenda®	Liraglutide	Dec 2014; Mar 2015 (weight management)	Authorized	Yes	3.0 mg daily (titrated)
Victoza®	Liraglutide	Jan 2010; Jun 2009 (T2DM)	Authorized	Yes	1.2 or 1.8 mg daily after 0.6 mg start
Ozempic®	Semaglutide	Dec 2017; Feb 2018 (T2DM)	Authorized	Yes	0.5, 1 or 2 mg weekly
Wegovy®	Semaglutide	Jun 2021; Jan 2022 (weight management)	Authorized	No	2.4 mg weekly (titrated)
Mounjaro®	Tirzepatide	May 2022; Sep 2022 (T2DM)	Not authorized	Informal market only	2.5-15 mg weekly (titrated)

**National comprehensive drug list at the end of 2024. All authorized GLP-1 products are prescription-only subcutaneous injections. "Marketed in Iraq" denotes commercial availability through licensed channels at the time of analysis. FDA, United States Food and Drug Administration; EMA, European Medicines Agency; T2DM, type 2 diabetes mellitus*

Table 2: Observed-to-expected (O/E) ratios for four a priori MedDRA System Organ Classes, GLP-1 ICSRs versus all non-GLP-1 ICSRs, Iraqi VigiFlow database, to December 2024

SOC	n/41	Comparator (%)	O/E	95% CI
Injury, poisoning (primary)	11	8	**3.4**	**2.0–5.6**
Gastrointestinal (positive control)	23	40	1.4	**1.1–1.8**
Psychiatric (secondary)	3	6	1.2	0.4–3.6
Metabolism (secondary)	4	12	0.8	0.3–**2.1**

†*Proportion of non-GLP-1 ICSRs coded to the same SOC, as reported in [source]; case-level denominators were not available. O/E = (n/41)/comparator proportion. 95% Cis by the Wald method on the log scale treating the comparator as fixed; they do not reflect uncertainty in the comparator and should be interpreted as approximate*

Table 3: Distribution of GLP-1 ICSR narratives across the five a priori coding categories (n = 41; Cohen's κ = 0.78)

Narrative category	n (%)	Representative descriptor
Cosmetic or non-medical off-label use	14 (34)	Self-initiated weight loss without baseline metabolic assessment
Procurement through unlicensed online or social media sources	9 (22)	Patients unable to verify batch, origin, or cold chain
Dosing or titration error	12 (29)	Started at maintenance dose without up-titration
Exposure during pregnancy	3 (7)	Inadvertent or off-label antenatal use
Suspected counterfeit or unauthorized product	8 (20)	Mounjaro® in Iraq; oral or spray "tirzepatide"

Categories are not mutually exclusive; some ICSRs were coded into more than one category, so percentages, calculated against all 41 ICSRs, add up to more than 100 %

Misuse and counterfeit narratives

Agreement between the two coders was substantial (κ = 0.78, 95 % CI 0.62 – 0.94) [14]. Table 3 gives the category counts after consensus. Cosmetic use was usually self-initiated, sometimes encouraged by social media influencers, and often started without any baseline metabolic assessment. Patients who bought products online could not verify origin, batch, or cold-chain integrity. Titration errors involved starting directly at maintenance doses, followed by prolonged or severe gastrointestinal effects. Three narratives described exposure during pregnancy, a use not recommended in the product information of any GLP-1 agent [21].

Public interest patterns

Interest in GLP-1 weight-loss injections in Iraq rose sharply from mid-2024 [9]. "Ozempic" and "Mounjaro" dominated in both English and Arabic, and "Saxenda" showed the lowest interest among the main brands. The metformin control showed no similar rise, which suggests that the GLP-1 trend reflected product-specific interest and not a general increase in health searches. The two languages followed a similar time pattern but differed in geography: Arabic transliterations were relatively more prominent outside Baghdad, particularly in southern governorates, whereas English searches clustered in Baghdad and the Kurdistan Region. Among the top 25 related queries for each brand, only a small fraction concerned side effects, dangers and risks. This pattern fits a benefit-focused information environment, but search data alone cannot measure public risk awareness [21].

Substandard and falsified medicine alerts

In 2024, the IPhVC issued thirty-six alerts on falsified medicines and forty on substandard medicines. In 2025, the total rose to eighty-two alerts, about half of which concerned falsified products. GLP-1 receptor agonists were prominent among the flagged products, together with anti-infectives and other alimentary tract and metabolism products, and all alerts were shared with the WHO GSMS. Three patterns emerged. First, falsified Ozempic® and Saxenda® pre-filled pens were flagged by WHO and the IPhVC, some containing the wrong active ingredient, too little active ingredient, or none [5,9,24]. Second, branded Mounjaro® vials and pens were found on the local market and through social media vendors, although the product is not authorized in Iraq. Third, by 2025, oral capsules and sprays falsely labeled as tirzepatide or Mounjaro® were being sold by informal online sellers, whereas authentic tirzepatide is authorized only as a subcutaneous injection [17].

Triangulation across data streams

The three streams moved together and not independently. Of 11 ICSRs whose narratives mentioned counterfeit, online or unlicensed supply, 7 (64 %) fell within ± 1 month of an SF alert for the same brand (Table 4).

Table 4: Triangulation matrix of Google Trends interest, ADR reporting, and SF alert activity for GLP-1 receptor agonists in Iraq

Product	Google Trends signal	ADR reporting signal	SF alert signal	Convergence within ± 1 month
Ozempic®	Sustained high RSV; few safety queries	Among most reported brands; GI and dosing-error narratives	Falsified product alerts shared with WHO GSMS	3 of 4 (75 %)
Mounjaro®	Sharp rise from mid-2024; high Arabic RSV	Reported despite no Iraqi authorization; off-label and counterfeit narratives	Multiple alerts, including oral capsules and sprays (2025)	3 of 4 (75 %)
Saxenda®	Lowest of main brands; rising late 2024	Largest share of branded reports	Falsified pre-filled pens flagged by WHO and IPhVC	1 of 3 (33 %)
Wegovy®	Modest interest	Few reports (authorized, not marketed)	No Iraq-specific alerts in window	Not applicable
Victoza®	Low interest (T2DM use)	Mainly gastrointestinal events	No major alerts in window	Not applicable
Metformin (control)	Stable RSV; no comparable rise	Not analyzed	Not analyzed	-

Convergence: proportion of ICSRs mentioning counterfeit, online or unlicensed supply that fell within ± 1 month of an SF alert for the same brand; pooled, 7 of 11 eligible ICSRs (64 %). Not applicable, no eligible ICSRs. ADR, adverse drug reaction; GI, gastrointestinal; GSMS, Global Surveillance and Monitoring System; RSV, relative search volume; SF, substandard and falsified. Data windows: Google Trends, January 2024-december 2025; ICSRs, all reports in the Iraqi VigiFlow database to 31st December 2024; SF alerts, 2024- December

Table 5: Time-lagged Spearman correlations (ρ, bootstrap 95 % CI from 1,000 resamples) between monthly Google Trends RSV and monthly GLP-1 ICSR counts, Iraq, 2024-2025

Search term	Lag zero	Lag 1 month	Lag 2 months	Lag 3 months
Mounjaro (English)	0.18 (−0.12, 0.45)	0.42 (0.10, 0.68)	0.36 (0.02, 0.63)	0.21 (−0.10, 0.49)
مونجارو (Arabic)	0.15 (−0.15, 0.44)	0.31 (−0.02, 0.59)	0.34 (0.01, 0.61)	0.19 (−0.13, 0.47)
Ozempic (English)	0.22 (−0.08, 0.49)	0.38 (0.06, 0.64)	0.29 (−0.04, 0.56)	0.16 (−0.16, 0.45)
أوزمبيك (Arabic)	0.20 (−0.10, 0.47)	0.33 (0.00, 0.60)	0.27 (−0.06, 0.55)	0.14 (−0.18, 0.43)
Metformin (control)	0.06 (−0.24, 0.34)	0.04 (−0.27, 0.33)	0.02 (−0.28, 0.32)	−0.01 (−0.31, 0.29)

A positive lag means that RSV preceded ICSR submission by the stated number of months. Estimates are exploratory, unadjusted for multiple comparisons and not interpreted as causal

For “Mounjaro,” correlations between RSV and ICSR counts reached ρ = 0.31 – 0.42 when RSV led by 1 – 2 months, and “Ozempic” showed similar values (Table 5). The bootstrap CI excluded zero for a few of these lead estimates, but they were not adjusted for multiple comparisons and are wide because the ICSR series is sparse. The metformin control showed no association. Correlations between RSV and SF alerts were weaker, and ICSR – SF alert correlations could not be estimated reliably because few months contained both events.

DISCUSSION

Three independent data streams, namely spontaneous ADR reports, public search interest and SF alerts, pointed to the same pattern of GLP-1 misuse and counterfeit penetration in Iraq. Interpretation remains cautious: with only 41 ICSRs, the reaction profile may be unstable, and parallel trends across the three streams may create chance temporal alignment. Even so, an O/E ratio of 3.2 for procedural complications, the presence of an unauthorized molecule in both ADR narratives and the SF register, and the 64 % convergence of counterfeit-related ICSRs with same-brand SF alerts are consistent with a non-random pattern. However, they do not prove it.

The main methodological contribution is to show that, where resources are limited, three free or routinely collected data sources can generate testable hypotheses about emerging medicine safety threats. Expressing triangulation through O/E ratios with CI [14], lagged correlations with a control term [13] and a priori convergence metric makes the approach reproducible. It can be applied to any product group in which public interest drives misuse, such as unauthorized hormones or unregistered weight-loss products. The gap between high product interest and few safety queries could also serve as an early-warning sensor: when interest in high-risk products rises sharply, regulators can prepare risk messages, alert health professionals and intensify SF surveillance.

The authorization and availability gap appears to drive misuse. Wegovy® is registered but not

marketed, and Mounjaro® is not authorized at all, yet both feature in public interest and appear in ADR narratives. Legitimate supply therefore lags demand, and counterfeiters and unauthorized vendors fill the gap [6]. Several actions follow these findings. A direct healthcare professional communication could remind community pharmacists and endocrinologists of prescription-only status, dose titration and contraindications. Patient-facing messages should be placed in the same social media channels where misuse is promoted, explaining how to recognize counterfeits, the risks of cosmetic use and the fact that no oral or spray form of tirzepatide exists. Enforcement should involve the Inspection Directorate, the National Center of Drug Control and Research and the Ministry of Youth and Sports. Given the links to fitness communities, informal online vendors need specific attention: regular monitoring of social media marketplaces, takedown requests to platforms and clear legal rules on online sale and advertisements of prescription-only medicines (POMs), since products often carry quality and safety risks [4].

Pharmacists submit most Iraqi ADR reports, so strengthening their pharmacovigilance knowledge, which remains uneven in comparable settings, would also improve detection [8,22].

Other explanations should be considered. Higher ADR reporting may partly reflect notoriety, reporting after the SF alerts themselves, a bias known to raise disproportionality measures [23]. Google Trends peaks may be driven by media coverage of regulatory action, creating a feedback loop in which alerts generate searches and searches prompt further alerts [21].

On the other hand, ADR reports probably underestimate harm, because counterfeit products reach gyms, online sellers and informal practitioners, and users harmed in these settings rarely enter the formal reporting system. The net effect of these biases is uncertain.

This study has several strengths. It is, to the authors' knowledge, the first country-level analysis to combine ADR, search and SF data in one pipeline with predefined quantitative metrics. Search was run in both English and Arabic with a non-GLP-1 control term, narratives were dual-coded with a reported κ, and all three data sources are free or routinely collected, which makes the framework feasible for other LMIC centers. Future work should replicate the framework in neighboring countries such as Jordan and Lebanon, run a full VigiBase disproportionality analysis, and build quarterly O/E, RSV and SF outputs into the routine IPhVC work.

Limitations of the study

With only 41 ICSRs, subgroup analysis was not possible; the reaction profile was unstable and the within-database O/E signal was preliminary pending confirmation against a VigiBase comparator. Lagged correlations were exploratory and unadjusted, and parallel trends may partly explain the alignment. Case-level counts for the non-GLP-1 comparator were not available, so comparator proportions were taken from aggregates, rounded data [10]; Cis treats these proportions as fixed and therefore does not capture comparator uncertainty, making them approximate and probably narrow. Google Trends reflects search interests rather than consumption and cannot distinguish information seeking, news-driven curiosity, or purchase intent; unequal Internet access and language preferences may also distort geographic patterns [21]. Detection-dependent SF alerts likely underrepresent counterfeits sold through encrypted channels, while stimulated reporting after alerts obscures the direction of association [23]. Finally, the single-country design cannot distinguish Iraqi from regional factors.

CONCLUSION

This study presents a reproducible triangulation framework that combines ADR reports, Internet search data and SF medicine alerts for early-warning pharmacovigilance in LMIC settings. Applied to GLP-1 receptor agonists in Iraq, it showed an O/E ratio of 3.2 for procedural complications, 64 % temporal convergence between counterfeit-related ICSRs and SF alerts, and lagged correlations between search interest and ADR reports. These together suggest, but do not prove, a non-random pattern of misuse and counterfeit penetration. Prospective validation, regional comparison and integration into routine workflow are the next steps.

DECLARATIONS

Acknowledgement/Funding

None.

Ethical approval

Approved by the Scientific and Ethics Committee of the College of Pharmacy, University of Baghdad (approval no. RECAUBCPO23047A, 15 April 2026).

Availability of data and materials

The line listing of GLP-1 SF alerts and the narrative coding framework, reviewer instructions, and disagreement log are available from the corresponding author upon reasonable request, subject to IPhVC approval.

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

All authors participated in collecting data, writing, and revising the final draft of the article.

REFERENCES

1. *Drucker DJ. Mechanisms of action and therapeutic application of glucagon-like peptide-1. Cell Metab 2018; 27(4): 740-756. doi: 10.1016/j.cmet.2018.03.001*
2. *Jastreboff AM, Aronne LJ, Ahmad NN, Wharton S, Connery L, Alves B, et al. Tirzepatide once weekly for the treatment of obesity. N Engl J Med 2022; 387(3): 205-216. doi: 10.1056/NEJMoa2206038*
3. *Whitley HP, Trujillo JM, Neumiller JJ. Special report: potential strategies for addressing GLP-1 and dual GLP-1/GIP receptor agonist shortages. Clin Diabetes 2023; 41(3): 467-473. doi: 10.2337/cd23-0023*
4. *Ashraf AR, Mackey TK, Schmidt J, Kulcsár G, Vida RG, Li J, et al. Safety and risk assessment of no-prescription online semaglutide purchases. JAMA Netw Open 2024; 7(8): e2428280. doi: 10.1001/jamanetworkopen.2024.28280*
5. *World Health Organization. WHO issues warning on falsified medicines used for diabetes treatment and weight loss. Geneva: WHO; 2024 (accessed 12 October 2026). Available from: https://www.who.int/news/item/20-06-2024-who-issues-warning-on-falsified-medicines-used-for-diabetes-treatment-and-weight-loss*
6. *Ozawa S, Evans DR, Bessias S, Haynie DG, Yemeke TT, Laing SK, et al. Prevalence and estimated economic burden of substandard and falsified medicines in low- and middle-income countries: a systematic review and meta-analysis. JAMA Netw Open 2018; 1(4): e181662. doi: 10.1001/jamanetworkopen.2018.1662*
7. *Uppsala Monitoring Centre. Programme members. Uppsala: UMC; 2026 (accessed 4 November 2026). Available from: https://who-umc.org/about-the-who-programme-for-international-drug-monitoring/member-countries/*
8. *Wilbur K. Pharmacovigilance in the Middle East: a survey of 13 Arabic-speaking countries. Drug Saf 2013; 36(1): 25-30. doi: 10.1007/s40264-012-0001-y*
9. *Hamasalih KT, Marouf BH. Knowledge, attitude and practice of community pharmacy staff toward pharmacovigilance and reporting of adverse drug reactions in Sulaimani City: a cross-sectional study. Iraqi J Pharm Sci 2025; 34(2): 29-39. doi: 10.31351/vol34iss2pp29-39*
10. *Iraqi Pharmacovigilance Center, Ministry of Health. GLP-1 analogues in obesity management: a national perspective. Pharmacovigilance Bulletin. 2024;2(2):7–8 (July–December 2024; published February 2025). Available from: https://storage.moh.gov.iq/2025/02/20/2025_02_20_12180339206_8606373221452472.pdf.*
11. *Brown EG, Wood L, Wood S. The medical dictionary for regulatory activities (MedDRA). Drug Saf 1999; 20(2): 109-117. doi: 10.2165/00002018-199920020-00002*
12. *Lindquist M. VigiBase, the WHO global ICSR database system: basic facts. Drug Inf J 2008; 42(5): 409-419. doi: 10.1177/009286150804200501*
13. *Mavragani A, Ochoa G. Google Trends in infodemiology and infoveillance: methodology framework. JMIR Public Health Surveill 2019; 5(2): e13439. doi: 10.2196/13439*
14. *Evans SJ, Waller PC, Davis S. Use of proportional reporting ratios (PRRs) for signal generation from spontaneous adverse drug reaction reports. Pharmacoepidemiol Drug Saf 2001; 10(6): 483-486. doi: 10.1002/pds.677*
15. *McHugh ML. Interrater reliability: the kappa statistic. Biochem Med (Zagreb) 2012; 22(3): 276-282. doi: 10.11613/BM.2012.031*
16. *World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human participants. JAMA 2025; 333(1): 71-74. doi: 10.1001/jama.2024.21972*
17. *European Medicines Agency. Saxenda, Victoza, Ozempic, Wegovy and Mounjaro: European public assessment reports and product information. Amsterdam: EMA; 2024 (accessed 12 October 2026). Available from: https://www.ema.europa.eu/en/medicines*
18. *U.S. FDA. Mounjaro (tirzepatide) injection. NDA 215866 approval letter, 13 May 2022. https://www.accessdata.fda.gov/drugsatfda_docs/nda/2022/215866Orig1s000Approv.pdf*
19. *U.S. FDA. Saxenda (liraglutide) injection. NDA 206321 summary review for regulatory action, Dec 2014. https://www.accessdata.fda.gov/drugsatfda_docs/nda/2014/206321Orig1s000SumR.pdf. For Victoza, Ozempic and Wegovy, follow the same pattern. Open each NDA on Drugs@FDA and use its "Approval Letter" PDF from the original approval (Orig1s000).*
20. *Nuti SV, Wayda B, Ranasinghe I, Wang S, Dreyer RP, Chen SI, et al. The use of Google Trends in health care research: a systematic review. PLoS One 2014; 9(10): e109583. doi: 10.1371/journal.pone.0109583*
21. *Udoye JA, Ozolua RI, Nwokike J. Assessment of the knowledge, attitude and practice of pharmacovigilance by pharmacists in two states in southeastern Nigeria.*

Trop J Pharm Res 2018; 17(5): 937-945. doi: 10.4314/tjpr.v17i5.25

22. *Pariente A, Gregoire F, Fourrier-Reglat A, Haramburu F, Moore N. Impact of safety alerts on measures of disproportionality in spontaneous reporting databases: the notoriety bias. Drug Saf 2007; 30(10): 891-898. doi: 10.2165/00002018-200730100-00007*